CALFED
BAY-DELTA
PROGRAM

Introduction to Restoration Targets

Workshop Packet

November 19, 1996
Sacramento

CALFED
BAY-DELTA
PROGRAM

1416 Ninth Street, Suite 1155
Sacramento, California 95814

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October 31, 1996

Dear Workshop Participant:

At the end of Phase I we identified three alternatives which are being refined in Phase II. For each alternative there are four Common Programs that address water quality, system vulnerability, water use efficiency, and ecosystem restoration. Also, each alternative contains two variable components which address water supply reliability through changes in conveyance and water storage. The alternatives vary in the amount and location of storage they propose and the manner in which they would convey water across the Delta.

Since the conclusion of Phase I and the designation of Common Programs and Alternatives, we have been refining and adding detail to the Ecosystem Restoration Common Program.

I hope you will join us at our Introduction to Restoration Targets Workshop on Tuesday, November 19, 1996 at the Beverly Garland Hotel, on 1780 Tribute Road, Sacramento, from 8:30 a.m. to 4:00 p.m.

We have invited two guest speakers who are implementing large-scale restoration programs to share their experience and join in our review. We think it will be a valuable opportunity to expand our collective understanding.

The second half of the workshop will be more technical. In this packet and at the workshop we will provide some detailed examples of the target setting process. We will also solicit your technical help to develop specific targets within your area of expertise or concern.

The materials in this packet will help you to follow our process to date and to effectively participate in the workshop. Please take the time to review them.

In late January we will offer another workshop to review and discuss a draft Ecosystem Restoration Program Plan. This plan will contain the refined Ecosystem Restoration Common Program at the level of detail necessary to conduct a programmatic environmental review.

Thank you for your continuing involvement in the CALFED Bay-Delta Program. Your help is making the Program a success.

Sincerely,

Lester A. Snow
Executive Director

WORKSHOP PREPARATIONS

LOCATION AND DIRECTIONS

The Beverly Garland Hotel
1780 Tribute Road
Sacramento, CA
(916) 929-7900

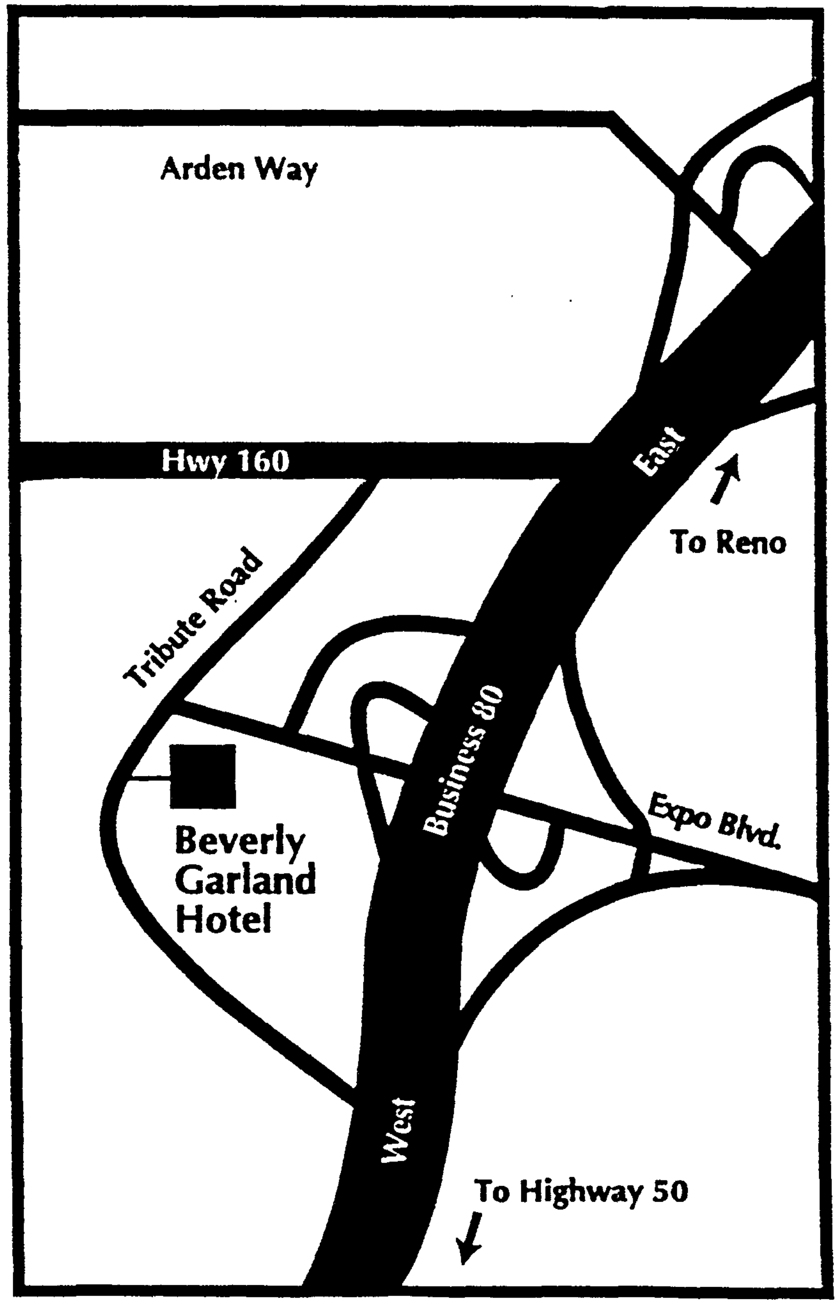
▸ **From San Francisco:**
Highway 80 towards Sacramento;
Business 80 East;
Cal Expo off Ramp;
Left onto Exposition Blvd.;
Left onto Tribute Road.

▸ **From Reno:**
Highway 80 towards Sacramento;
Business 80 West;
Cal Expo off Ramp;
Right onto Exposition Blvd.;
Left onto Tribute Road.

▸ **From Stockton:**
Interstate 5 towards Sacramento;
Business 80 East;
Cal Expo off Ramp;
Left onto Exposition Blvd.;
Left onto Tribute Road.

▸ **From Tahoe:**
Highway 50 towards Sacramento;
Business 80 East;
Cal Expo off Ramp;
Left onto Exposition Blvd.;
Left onto Tribute Road.

▸ **From Fresno:**
Highway 99 towards Sacramento;
Business 80 East;
Cal Expo off Ramp;
Left onto Exposition Blvd.;
Left onto Tribute Road.



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Workshop Agenda

Introduction to Restoration Targets

November 19, 1996
Beverly Garland Hotel
Sacramento, California

8:30 Registration (CALFED staff)

9:00 Welcome and Introductions (Lester Snow)

CALFED Process Overview (Lester Snow)

Ecosystem Restoration Program Plan Process (Lester Snow)

Targets Development Process (Dick Daniel and Panelists)

Participant Questions and Comments (Dick Daniel)

12:00 Lunch

1:00 Targets Example Presentations (Frank Wernette, Terry Mills)

Participant Questions and Comments on Draft Targets (Dick Daniel)

Short-Term Ecosystem Restoration Coordination (Cindy Darling)

Next Steps in the Process (Lester Snow and Dick Daniel)

4:00 Adjourn

INTRODUCTION TO WORKSHOP

WORKSHOP PURPOSE

This workshop will explain how CALFED will develop ecosystem targets and it will give you a chance to help develop the targets. The workshop will also explain how the relationship of restoration targets relates to the Ecosystem Restoration Program Plan. This workshop is one of several public meetings scheduled to help CALFED refine the Ecosystem Restoration Common Program in Step One of the Phase II Process, described in the "Overview of the CALFED Phase II Process" section of this packet.

Ecosystem restoration is one of four programs common to all alternatives being assessed in the CALFED Programmatic Environmental Impact Report/Statement (EIR/S). The other common programs are water use efficiency, system integrity and water quality.

This packet contains background material on the Ecosystem Restoration Program and the process of developing restoration targets. Available at the workshop will be a set of draft targets for public review and comment.

INSTRUCTIONS AND GROUND RULES FOR PARTICIPANTS

Before attending the workshop, please read this packet. To help everyone participate, we will use the following ground rules to maximize the opportunity to participate:

- Please wait for the moderator to call on you to comment or ask questions.
- Please phrase questions and comments clearly and concisely.
- Please show respect for the views of other Workshop participants.
- No person or interest group will dominate the question and answer period.

Also enclosed in the packet is a worksheet for your comments and ideas. ***Please complete and mail in the worksheet*** whether or not you attend the workshop.

PANEL DESCRIPTION & INTRODUCTIONS

The purpose of the Panel Discussion is to help CALFED and stakeholders evaluate and validate the process of developing ecosystem targets. The two panelists represent ecosystem restoration programs in the Great Lakes and Louisiana, programs which are further along than the CALFED Bay-Delta Program. CALFED welcomes their insights and expects to benefit from their experience as we further develop the Ecosystem Restoration Program. Below are brief descriptions of each panelists' background and expertise.

Mr. David Fruge - Field Supervisor, U.S. Fish and Wildlife Service, Lafayette, Louisiana. As the Department of Interior's representative on the Louisiana Coastal Wetlands Conservation and Restoration Task Force, Mr. Fruge coordinates the input of five of the Department's bureaus involved in the Task Force's wetland restoration activities.

Mr. Fruge received a Master of Science degree in Biology from Northeast Louisiana University in 1971.

Most of Mr. Fruge's 25 year career has been devoted to wetlands conservation, particularly in Louisiana. He is a strong advocate of wetlands preservation and restoration, utilizing the capabilities of both the public and private sector.

Mr. Fruge was Chairman of the Louisiana-Mississippi Habitat Advisory Panel for the Gulf of Mexico Fishery Management Council from 1989 to 1994. Mr. Fruge also served as Chairman of the Mississippi River Coastal Wetlands Initiative for the North American Waterfowl Management Plan between 1988 and 1993.

Ms. Karen Holland - Great Lakes Ecosystem Protection and Restoration Team Leader, U.S. Environmental Protection Agency (EPA), Chicago Illinois. The team Ms. Holland leads is housed in the Great Lakes Water Program Office. She has been with EPA for over six years and has a great interest in doing volunteer restoration work. This interest motivated her to get a Master of Science degree in Environmental Studies from Northeastern Illinois University and to join EPA on this important project.

PARTICIPANT WORKSHEET

PARTICIPANT WORKSHEET

INTRODUCTION TO RESTORATION TARGETS

CALFED staff are seeking in-depth responses from you about the process for developing ecosystem restoration targets and about the draft targets themselves. After considering the material in this packet and distributed at the workshop, please respond to the questions on this worksheet. If you do not have a copy of the draft targets report distributed at the workshop, you may obtain a copy after the workshop by contacting Dick Daniel, CALFED Ecosystem Restoration Program Manager at 916/657-2666 or in writing at CALFED Bay Delta Program, 1416 Ninth Street, Sacramento, CA 95814.

Please explain your rationale and where possible, list source documents when recommending changes, additions or deletions to specific draft targets. The deadline for submitting responses and comments is **January 6, 1997.** Please send or fax your comments to Mr. Daniel; the CALFED fax number is 916/654-9780.

CALFED staff will consider your comments as they work on the restoration targets. As targets are refined, future drafts of the targets report and the Ecosystem Restoration Program Plan will explain how your comments are addressed.

Comments on the Targets Development Process

What questions or comments do you have about the targets development process?

Does the process reflect a reasonable approach for developing the Ecosystem Restoration Program targets?

Comments On Targets

How well do the draft targets help the Ecosystem Restoration Program meet its objectives?

What suggestions do you have for completing the list of targets? Please include in your your rationale, and where possible back-up documentation, literature citations and references.

Do you have suggestions for the format or the topics to be addressed at the next Ecosystem Restoration Program workshop?

Do you have additional suggestions for developing the targets or the Ecosystem Restoration Program Plan?

CALFED SOLUTION PRINCIPLES

D-026021

SOLUTION PRINCIPLES

INTRODUCTION

Solution principles are the fundamental principles which guide development and evaluation of the Program alternatives by the CALFED Bay-Delta Program. The solution principles provide an overall measure of the acceptability of alternatives and guide the design of the institutional part of each alternative.

DEFINITIONS AND CRITERIA FOR SOLUTION PRINCIPLES

The six principles are an integral part of the CALFED Bay-Delta Program mission statement and are intended to be used collectively. Following are draft definitions for each solution principle and draft criteria for their application:

Reduce Conflicts in the System

A solution will reduce major conflicts among beneficial users of water. A solution should:

- significantly reduce each of the four major conflicts which have been identified for the Bay-Delta system. Most of the problems in the Bay-Delta are embodied in one or more of these conflicts. They are:

  - fisheries and diversions
  - habitat and land use/flood protection
  - water supply availability and beneficial uses
  - water quality and land use

Equitable

An equitable solution will focus on solving problems in all problem areas. Improvements for some problems will not be made without corresponding *improvements for other problems.* Equitable considerations include:

- satisfy some portion of each of the 4 primary and 14 secondary objectives which have been identified for the Program.
- provide a reasonable balance of reliability weighted[1] improvements for the four resource areas. Balance does not necessarily require an equal level of improvement for each resource area (e.g. water exporters might be willing to accept less improvement in water supply reliability if water quality is significantly improved).
- result in costs allocated to the economic users of water based on the benefits they receive from the solution. However, there is no obligation to provide benefits to those unwilling to contribute towards the solution.
- result in net benefits and burdens balanced across stakeholder groups.

Affordable

An affordable solution will be one that can be implemented and maintained within the foreseeable resources of the Program and stakeholders. An affordable solution should:

- have identifiable revenue and financing provisions which are adequate for implementation and continued maintenance of the solution.
- be among the least expensive solutions, for a given level of implementation, which achieve the Program objectives.
- minimize the negative effects on the credit rating of those funding the solution.

[1] In order to recognize the potential for uncertainty and differences in timing in the receipt of benefits, benefits may be weighted by the degree of probability that the benefit will be received as anticipated. Benefits which appear more certain would have a higher weighted value, while those with less certainty due to timing or technical issues would have a lower weighted value.

Durable

A durable solution will have political and economic staying power and will sustain the resources it was designed to protect and enhance. A durable solution should:

- be adaptive, flexible to changing needs and potential future conditions, and able to address biological uncertainty to sustain the resources it was designed to protect and enhance.
- provide ecosystem improvement using a variety of mechanisms to better face biological uncertainty rather than relying on any single theory of ecosystem improvement.
- accommodate hydrological and other physical uncertainties (e.g. increased storage would hedge against the unknown, or consideration of impacts of potentially higher sea levels on the various alternatives could strengthen durability).
- have adequate legal, operational or physical provisions to ensure that objectives continue to be met in an equitable way for the long-term.
- include a financial plan which has provisions to ensure that the solution will be implemented as intended, while providing flexibility to alter revenues to respond to changing future needs.

Implementable

An implementable solution will have broad public acceptance, legal feasibility and will be timely and relatively simple to implement compared with other alternatives. An implementable solution should:

- have legal or practical precedents or have a clearly identified series of reasonable steps which could be taken to enable implementation.
- have institutional feasibility.
- include as few major legal and institutional changes as necessary while meeting Program objectives.
- have broad acceptance across the various geographic areas and interest groups

as well as the state as a whole.

- be timely (can be implemented relatively quickly) and is relatively simple compared with other potential solutions.

No Significant Redirected Impacts

A solution will not solve problems in the Bay-Delta system by redirecting significant negative impacts, when viewed in its entirety, in the Bay-Delta or other regions of California. A solution should:

- minimize negative long-term economic impacts at the regional level.

- compensate for or mitigate unavoidable negative impacts to the greatest extent practicable.

OVERVIEW OF PHASE II PROCESS

OVERVIEW OF CALFED PHASE II PROCESS

The following chart illustrates the steps in Phase II of the CALFED process for developing a Bay-Delta solution. The purpose of Phase II is to refine the Phase I alternatives, add detail to a level which allows them to be evaluated or analyzed as part of the EIR/S process, and conduct pre-feasibility studies to facilitate a smooth transition to Phase III.

The three alternatives address Bay-Delta problems comprehensively. They share a common program that includes water use efficiency measures, ecosystem restoration, water quality protection, and levee improvements. Also, they all include a range of water storage options. They differ in their conveyance systems -- their approaches to moving water. Alternative 1 uses the existing system of Delta channels; Alternative 2 uses the existing system but with significant modifications; and Alternative 3 uses both the existing system, with significant changes, and an isolated facility.

From these alternatives, one preferred alternative will be chosen after completion of the three parts of Phase II:

- Alternative Refinement that adds details and specifics;
- Alternative Evaluation which evaluates impacts and prepares environmental documents under the California Environmental Quality Act and National Environmental Protection Act; and
- Implementation planning to develop the assurances, financing plans and technical pre-feasibility studies required to move into Phase III.

The following paragraphs describe the Phase II steps. Stakeholders and the public will have opportunities to review work products developed at each step in the Phase II process, and to offer comments and suggestions for refinement.

During **Step One** CALFED will refine the five components (storage and conveyance, ecosystem restoration, water supply, water quality, and levee system integrity) which make up the alternatives. For each component, priorities for actions will be set based on technical and cost effectiveness; detail will be added (ranges of size, locations, general configuration), components will be evaluated against goals, objectives and solution principles, and ranges of implementation will be further defined. The Step One product will be a more detailed description of the five components.

The objective for **Step Two** is to describe the interaction among components. Up to this point, CALFED has developed and refined the components individually. In Step Two we will evaluate opportunities to make the programs more efficient. For example, one component might have an action to create habitat, while another might have actions to modify and strengthen levees. The two actions may be combined to improve cost effectiveness. CALFED and stakeholders will test the alternatives and interaction of components against the goals, objectives and solution principles. The product of Step Two is a description of each alternative -- a combination of common and variable components working together in a coordinated fashion.

Once alternatives have been described in detail in Step Two, work done in **Step Three** will describe how they would operate and assess their benefits (against goals, objectives and solution principles) and costs. For example, CALFED will produce hydrographs showing flows, detailed maps of project features, and cost estimates. The product of Step Three will be a description of the operations, benefits, and costs of alternative programs in enough detail to distinguish them and permit the impacts of each to be analyzed.

Step Four begins the Alternative Evaluation portion of Phase II. In this step, CALFED will identify the environmental benefits and detriments of the alternatives. Simultaneously, cost/benefit analyses will be conducted for each alternative. Again, the alternatives will be evaluated against the goals, objectives and solution principles. The product of Step Four will be the draft preferred alternative.

In **Step Five** CALFED will prepare the Draft Programmatic EIR/EIS, which will describe the draft alternatives and environmental effects identified in Step Four. Once the formal document is produced, CALFED will circulate it for another round of public review and comment. Comments will be carefully recorded for consideration in preparing the Final EIS/EIR. The product of Step Five is the Draft Programmatic EIR/EIS.

Finally, in **Step Six**, CALFED will prepare a Final Programmatic EIS/EIR incorporating the comments received on the Draft EIR/EIS and describing the preferred alternative in detail.

Throughout Phase II, CALFED and stakeholders will develop and refine an **implementation strategy** consisting of preliminary assurances, financial analyses, and pre-feasibility studies.

Programs in the preferred alternative will be described generally. Prefeasibility analysis will help make the alternatives more specific. For example, the Ecosystem Restoration Program may include the following objective: "improve fish passage on tributary streams." Pre-feasibility analysis may identify for a specific stream structural modifications and their locations. Preliminary facility planning and design will support detailed project financing and permitting requirements. The resulting project description, financing plan, and assurance requirements will support project level environmental analysis in Phase III. A project level environmental review will be completed for all projects.

In summary, the objective of Phase II is to identify a preferred program, along with the information required to begin implementing individual projects in Phase III.

General Phase II Process

Alternative Refinement

ALTERNATIVE
Common Programs and Variable Components

Phase I Alternatives

STEP ONE
Refine Components

STEP TWO
Detail Interactions Between Components

STEP THREE
Describe Operations and Identify Benefits/Costs

Alternative Evaluation (CEQA/NEPA)

STEP FOUR
Analyze Impacts of the Alternative Programs

STEP FIVE
Prepare Draft Programmatic EIR/S

STEP SIX
Prepare Final Programmatic EIR/S

PHASE III
Project Level Environmental Analysis and Implementation

Implementation Strategy

- Preliminary Assurances
- Financial Analysis
- Prefeasibility Studies

CALFED BAY-DELTA PROGRAM

D-026030

DEVELOPING THE ECOSYSTEM RESTORATION PROGRAM PLAN

ECOSYSTEM RESTORATION STRATEGY

This paper outlines the CALFED vision and strategy for restoring a healthy Bay-Delta system. This strategy is based on the restoration of ecosystem elements (habitats and plant and animal populations and communities) and natural processes (functions) that support the elements. A healthy ecosystem is one that exhibits a natural array, quantity, and quality of habitats and associated populations and communities of desirable species of plants and animals. A healthy ecosystem also has natural processes that meet the basic needs of the desirable plants and animals.

The ecosystem restoration program is based on a mission, vision, objectives, goal and strategy for ecosystem restoration. Among these, the mission, vision, goal and objectives are expected to change little as the Program proceeds. The strategy, guided by adaptive management, will likely be the subject of continuing adjustment of actions as restoration efforts proceed and as stressors change. An essential part of an ecosystem restoration strategy is a plan for ensuring that restoration activities continue to occur until objectives are achieved, and that adequate provisions are made for the continued maintenance and protection of the restored system. Included in this strategy paper is a description of the conditions that must be met to assure proper protection and management of a restored Bay-Delta ecosystem.

PURPOSE OF THIS DOCUMENT

The CALFED Bay-Delta Program is developing a comprehensive solution to resource problems of the Bay-Delta system. These problems are related to water supply reliability, water quality, levee system integrity, and ecosystem restoration. An Ecosystem Restoration Strategy is needed to provide the overall approach and direction for development, implementation, and management of an ecosystem restoration program.

This strategy document has four purposes:

- describes CALFED's vision of a healthy and restored ecosystem;
- describes the strategy to develop, implement, and manage the ecosystem program;
- demonstrates that the strategy is based on an ecosystem approach guided by flexible adaptive management; and
- serves as a focus to develop understanding and support for the restoration program among

VISION OF A RESTORED ECOSYSTEM

CALFED is working to achieve a healthy Bay-Delta ecosystem that provides for the needs of plants, animals, and people using the system. This healthy ecosystem will include a range of sustainable habitat types that provide environmental, recreational, and aesthetic benefits. It will support natural production of an abundance of resident and anadromous fish, including viable recreational and commercial fisheries. A healthy ecosystem will also support sustainable production and survival of plant and wildlife species, including resident species as well as migrants such as the waterfowl that use the Pacific Flyway each winter. These qualities are the benefits or ecosystem services that a healthy Bay-Delta ecosystem will provide.

These sustainable fish, wildlife, and plant populations depend on an ecosystem that provides all the natural processes, called ecosystem functions, that they need. Though the Bay-Delta system will never be returned to the conditions that existed prior to human disturbance, ecosystem functions will be restored to levels needed to support Bay-Delta species at natural sustainable levels and at levels where they will not be threatened or endangered with extinction. A healthy functioning ecosystem will include all the habitats necessary for survival of species that use the system, including for example freshwater and brackish tidal marsh, shallow water, riparian woodlands, and shaded riverine areas. These habitats will be large enough in area to support sustainable populations of Bay-Delta species, and will be interconnected to allow movement and prevent isolation of plant or animal populations. To the extent possible, natural processes of the system will be restored, including for example, proper water flow to ensure appropriate salinity levels, meander belts that create necessary habitat and generate sediments that are important to the system, and nutrients that support the food web of the system. Human pursuits that affect the Bay-Delta ecosystem will be managed to complement ecosystem health, maintaining water that is free of toxic contaminants, and encouraging agricultural land uses that are compatible with wildlife.

PROBLEMS AND PROGRAM GOALS AND OBJECTIVES

The CALFED Bay-Delta Program has developed problem statements, goals and objectives for each of the four critical resource areas being addressed by the Program: ecosystem quality, water supply reliability, water quality, and levee system vulnerability. Problems were identified and goals and objectives set through an open process involving a series of public workshops, meetings of the Bay-Delta Advisory Council, and other public and agency input. Problems were identified first, and then objectives were developed to correspond to each problem. A program mission statement completes the statements.

The Program mission, goal and objective statements for ecosystem quality are reproduced below. The full set of ecosystem quality problem statements is reproduced in Appendix A of this document. The Program has documented all its problems and objectives in a "Problem/Objective Definition" paper dated March 1996.

Program Mission

The mission of the CALFED Bay-Delta Program is to develop a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta system.

Ecosystem Quality Goal and Objectives

GOAL

Improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species.

OBJECTIVES

A. **Improve and Increase Aquatic Habitats** so that they can support the sustainable production and survival of native and other desirable estuarine and anadromous fish in the estuary.

1. **Increase Amount of High Quality Shallow Riverine Habitat** to allow sustainable fish spawning and early rearing.

    a. **Increase Amount of Quality Riverine Edge Habitat** to allow spawning and rearing by sustainable populations of native fish species.

    b. **Increase Amount of Quality Shallow Shoal Habitat** within the main channels of the Delta and upper Bay to allow shallow foraging by sustainable populations of juvenile estuarine fish.

2. **Increase Amount of High Quality Shaded Riverine Habitat** to allow the growth and survival of sustainable populations of estuarine resident and anadromous fish in the estuary.

    a. **Increase Amount of Quality Riparian Woodland Habitat** to allow production of terrestrial food sufficient to support sustainable populations of resident and anadromous fish.

b. **Increase Amount of Large, Woody Debris** along Delta levees to allow juvenile and adult feeding and refuge for sustainable populations of fish.

c. **Increase Amount of Shaded Riverine Habitat** to provide for localized temperature reduction.

3. **Increase Amount of Quality Tidal Slough Habitat** containing emergent and submerged vegetation to support the fish production capacity of the Delta.

a. **Increase Amount of Dead-End Slough Habitat** to allow spawning and rearing of sustainable populations of some resident species.

b. **Reduce Water Hyacinth** populations in tidal slough habitats to improve habitat quality for sustainable populations of Delta fish.

c. **Increase Amount of High Quality Tidal Slough Habitat** to allow increased primary biological production.

4. **Increase Amount of High Quality Estuary Entrapment/Null Zone Habitat** to support sustainable fish populations in the Bay-Delta system.

a. **Reduce Saltwater Intrusion** into Suisun Bay to increase the nursery area for sustainable populations of plants and animals.

b. **Expand** the geographic extent of **Low Salinity Habitat** in Suisun Bay.

c. **Increase** the occurrence of **Brackish Water Habitat** in San Pablo Bay during the winter and spring to support sustainable populations of Bay species.

5. **Provide Sufficient Transport Flows** at the proper times to move eggs, larvae, and juvenile fish from spawning habitats to nursery habitats in the Delta and Bay.

a. **Increase the Transport of Young Fish from the Delta to Suisun Bay** nursery areas to support sustainable populations of important estuarine species.

b. **Increase the Transport of Young Fish Through the Delta** to the ocean to support sustainable populations of estuarine and anadromous fish species.

c. **Reduce the Transport of Young Fish from North to South across the Delta** and the entrainment of fish in the Delta to increase the survival and abundance of estuarine and anadromous species.

d. **Reduce the Blockage of and Alterations to Transport Flows** by local structures.

6. **Reestablish Appropriate upstream and downstream movement** of anadromous and estuarine fish.

a. **Enhance Upstream Migration of Adult Salmonids** through the Delta.

b. **Increase Successful Outmigration of Juvenile Fish** through the Delta.

c. **Enhance Upstream Migration of Adult Estuarine Fish** into the Delta and river spawning areas.

7. **Improve the Productivity of the Bay-Delta Aquatic Habitat Food Web** to support sustainable populations of desirable fish (and other) species.

a. **Reduce Entrainment** of biological productivity throughout the aquatic food web.

b. **Reduce Concentrations of Toxicants** in the water column and in sediments.

c. **Reduce the Effects of Introduced Species** on ecosystem productivity and in competing with desirable species for habitat.

d. **Increase the Residence Time of Water in Delta Channels** to increase plankton productivity and reduce undesirable algal-mat growth in the Delta.

e. **Increase the Input of Nutrients** from wetland and riparian habitats to aquatic habitats.

f. **Reduce Salinity Levels** in Delta aquatic habitats.

g. **Increase Flows of Freshwater** into the estuary.

8. **Reduce Concentrations of Toxic Constituents and Their Bioaccumulation** to eliminate their adverse effects on populations of fish and wildlife species.

a. **Reduce the Concentrations of Pesticide Residues** in Bay-Delta system water and sediments.

b. **Reduce the Concentrations of Hydrocarbons, Heavy Metals, and other Pollutants** in Bay-Delta system water and sediments.

B. **Improve and Increase Important Wetland Habitats** so that they can support the sustainable production and survival of wildlife species.

1. **Increase the Amount of High Quality Brackish Tidal Marsh Habitat** in the Bay-Delta system to better support sustainable populations of native wildlife species.

a. **Modify salinity levels in Brackish Tidal Marshes** to improve their vegetation composition.

b. **Increase the Areal Extent** of brackish tidal marsh habitats.

c. **Improve the Connectivity** between brackish tidal marsh habitats and their supporting habitats such as aquatic habitats and riparian woodlands and adjacent uplands.

2. **Increase the Amount of High Quality Freshwater Marsh Habitat** to better support sustainable populations of native wildlife species in the Delta.

a. **Restore Appropriate Salinity Levels** in freshwater marsh habitat in the Delta to enhance forage productivity and habitat suitability for some native species.

b. **Increase the Areal Extent** of freshwater marsh habitats.

c. **Improve the Connectivity** among freshwater marsh habitats to provide corridors for population movement and genetic exchange for dependent species.

d. **Reduce the Vulnerability** of existing freshwater marshes to levee failure.

3. **Increase the Amount of High Quality Riparian Woodland Habitat** in the Delta to better support sustainable populations of native wildlife populations.

a. **Increase Amounts of Riparian Habitat Structure** for nesting near foraging areas for some native bird species.

b. **Reduce the Fragmentation** of riparian woodland habitat patches to provide corridors for population movement and genetic exchange for dependent species.

c. **Increase the Areal Extent** of riparian woodland habitats.

d. **Improve the Connectivity** between riparian woodlands and their supporting habitats such as aquatic habitats and brackish marsh habitats.

4. **Increase the Amount of Breeding Waterfowl Habitat** to better support sustainable populations of dabbling ducks.

a. **Increase the Amount of High Quality Brood Habitat** near nesting habitat for dabbling ducks.

b. **Increase the Amount of High Quality Nesting Habitat** near brood habitat for dabbling ducks.

5. **Increase the Amount of Wintering Wildlife Habitat** for foraging and resting to better support sustainable populations of wintering waterfowl.

   a. **Increase** supplies of suitable forage such as **Waste Grain** on agricultural lands.

   b. **Increase** the amount of **Resting Areas** near foraging areas for wintering wildlife.

   c. **Increase** the amount of high quality **Foraging Areas** (e.g. freshwater marsh and brackish water marsh) for wintering wildlife.

   d. **Reduce the Vulnerability** of some existing wintering wildlife habitats to levee failures.

6. **Increase the Amount of Managed Permanent Pasture Habitat for** to better support wintering crane populations.

   a. **Increase** the amount of **Foraging Habitat** in proximity to roosting habitat.

   b. **Increase** the amount of **Roosting Habitat** in proximity to foraging habitat.

7. **Increase Flood Plains and Associated Riparian Habitat** to improve diversity and sizes of fish and wildlife populations.

   a. **Increase** suitable flood plains to improve the availability of **Temporary Flooded Spawning Habitat** for fish.

   b. Improve narrow restricted channels to **Reduce the Risk of Catastrophic Losses** of wildlife habitat from levee failure.

C. **Increase population health and population size** of Delta species to levels that assure sustained survival.

1. **Contribute to the recovery** of threatened, endangered or species of special concern.

2. **Increase populations** of economically important species.

3. **Increase populations** of prey or food species.

BAY-DELTA ECOSYSTEM SERVICES, FUNCTIONS, AND LIMITING FACTORS

Three concepts that are central to the CALFED ecosystem restoration program are *ecosystem services, ecosystem functions*, and *limiting factors*. An ecosystem service is a benefit (i.e. output) of an ecosystem provided to humans. Examples of ecosystem services may include:

- water supply valued for multiple beneficial uses,
- a sustainable and relatively-complete Bay -Delta ecosystem mosaic (valued for its recreational and aesthetic qualities),
- sustainable populations of commercially and recreationally valuable fish species (such as chinook salmon, steelhead, and striped bass),
- sustainable populations of other special-status plant and animal species (such as Delta and longfin smelt, splittail, green sturgeon, greater sandhill crane, and other native fish, animal, and plant species), and
- capability to absorb flood flows without damaging land uses and infrastructure.

An ecosystem function is a process in an ecosystem that determines the ecosystem's ability to provide a corresponding service. Ecosystem functions include processes within and between ecosystems that contribute to the development and maintenance of the ecosystem and therefore control its ability to provide services. Critical ecosystem functions that are impaired may constitute limiting factors for populations of fish or other organisms that comprise important ecosystem services. Ecosystem functions may include:

- nutrient cycling, through aquatic, wetland and upland habitats ecosystem services. Ecosystem functions may include:

- nutrient cycling, through aquatic, wetland and upland habitats
- hydrological and hydraulic regimes, within Bay/Delta water courses that support food web, transport, habitat, and migration of aquatic species
- primary and secondary productivity, that support the aquatic food web
- connectivity between important related and dependent aquatic, wetland, and upland habitats
- transport of early life stages of fish populations from spawning grounds to nursery areas

Limiting factors or stressors include limited food supply, lack of important habitat, lack of aquatic flows, or poor water quality. Any one or combination of factors may limit populations of valuable plant and animal species.

Those ecosystem functions and limiting factors that are well known and documented to control or limit important fish populations or other important ecosystem services will be the focus of the CALFED Program. For example, certain water diversions are well known to severely affect important fish populations during critical life stages. Screening of these high priority diversions by the CALFED Program will likely be broadly accepted by agencies and the public.

Other ecosystem functions or limiting factors may need more study to conclusively demonstrate their relationships to important ecosystem services. These functions or factors requiring more investigation will be excellent candidates for addressing using an Adaptive Management approach. For example, the direct causal relationship between certain flow patterns (e.g. seasonally) in the Delta and the survival of a fish population may be uncertain. This potential relationship could be investigated using a pilot project that manipulates flows and monitors the fish population to determine the benefit or impact of those flows; subsequent flow patterns would be adaptively managed based on the results of the pilot project.

PROGRAM STRATEGY

The vision is the picture of what the Bay-Delta ecosystem should look like when the mission is factors which degrade habitat, impair ecological functions, or reduce the population size or health of species. The Program will focus on those factors that cause direct mortality of plants and animals in the system, or cause indirect mortality by degrading habitat conditions or functions. The Ecosystem Restoration Strategy reflects the Program goal and objectives. In addition the strategy also emphasizes the following.

Limiting Factors When there is a single factor limiting an ecological function or species, remedial actions are often clear. However, there are many stressors that reduce ecological functions or cause mortality of species in combination or at different stages in the species life cycle. Often the processes are complex and poorly understood. In the Bay-Delta system, some of these include inadequate physical habitat for reproduction, foraging, or escaping from predators; inadequate water quality including temperature and toxic contaminants; fragmented habitat that impedes migration; inadequate or altered water flow regimes; direct and indirect mortality caused by water diversions from the system; the presence of undesirable introduced species that compete with or prey upon other species; recreational and commercial harvest; and or even such factors as recreational boating. In cases where there are multiple stressors affecting species, the strategy of the Program is to take a broad ecosystem approach, making incremental improvements in all the significant identified factors that affect important species and their habitats.

The Program will start by addressing factors likely limiting species of special concern such as winter and spring run chinook salmon, delta smelt, and Sacramento splittail. Subsequent efforts will work to protect or restore other ecosystem functions. Actions will be guided toward de-listing these species as threatened or endangered.

Natural Processes With limiting factors as the focus of the program, there will be need to select actions that favor those factors that take advantage of natural processes to achieve desired results. This will reduce the amount of effort necessary to sustain restoration benefits, and increase the likelihood of long-term success of the program.

Resilience Actions will be prioritized by their ability to restore some of the system's natural resilience to disturbance. Habitat restoration will be directed toward natural processes such as river meander belts that are self sustaining. Actions will also be spread throughout the system, to ensure genetic diversity will be protected for species with widespread distributions.

Achieving Multiple Benefits Efforts will be made to increase benefits by selecting or designing actions that improve habitat conditions or ecological functions for multiple species. Actions will also be favored if they improve other resource areas including water quality, system integrity, and water supply reliability as well as improving ecosystem quality.

Measurable Results Program results will be measured through monitoring and research. Actions will first be designed and implemented so that their effectiveness is measurable. The Program will include monitoring to assess the overall success of actions implemented. This will allow adaptive management of the restoration effort: adjustment of our actions to make them more effective, and changes in emphasis as the condition of the ecosystem improves.

Adaptive Management Where uncertainty exists in how to implement actions or on potential benefits, adaptive management will guide the program. Actions will be implemented on a pilot scale to refine uncertainty techniques and to measure previously unknown potential success. The Program will adjust as necessary to achieve objectives. In many cases natural variability in the ecosystem will also force Program adjustments.

Make up for Unavoidable Losses Where competing uses of Bay-Delta resources make it impossible to avoid indirect affects on species, habitats, or ecological functions, efforts will be made to compensate by reducing other causes of mortality or improving habitats and functions elsewhere in the Bay-Delta system.

The CALFED restoration program will be coordinated with other long-term restoration programs in the Central Valley including the following:

- Comprehensive Conservation Management Plan - U.S. Environmental Protection Agency (EPA)/San Francisco Estuary Project
- Central Valley Fish and Wildlife Restoration Program - U.S. Fish and Wildlife Service
- Anadromous Fish Recovery Plan - Anadromous Fisheries Recovery Plan
- Salmon and Steel Head Management Plan - CA Department of Fish and Game
- Recovery Plans For endangered species (Delta Native Fishes, Winter-Run Chinook Salmon, Salt Marsh Harvest Mouse, Swainson's Hawk, Giant Garter Snake, etc.)
- Battle Creek, Deer, Mill Creek Restoration Plans (Memorandums of understanding)
- Corps Sacramento River Bank Protection Project Comprehensive Corridor Management Plan
- Upper Sacramento River Fisheries And Riparian Habitat Management Plan - SB 1086
    - Riparian Habitat Restoration Plan
    - Fisheries Restoration Plan
- San Joaquin River Habitat Restoration Plan
- Lower Mokelumne River Management Plan

- Central Valley Habitat Joint Venture/North American Waterfowl Management Plan

The CALFED Ecosystem Restoration Program will focus efforts by watersheds. In this way, the Program can take advantage of existing or planned restoration efforts in the various watersheds of the Central Valley.

INDICATORS

Indicators are attributes of the Bay-Delta be measured to gauge our success in maintaining or achieving desirable functions or conditions. Benchmarks that indicate performance (i.e. good or bad) will help establish specific target levels. The following is a list of potential indicators.

Water Quality: nutrients (phosphorous, nitrogen/nitrate, carbon [TOC, DOC, POC]), wastewater discharge, water temperature, salinity, toxics (heavy metals, organic pesticides, hydrocarbons-petrochemicals, noxious algal blooms, BOD, water clarity, etc.

Wetland habitat quantity/quality: area or length of berm islands, ratio of degraded to high quality wetland habitat, area or linear edge of emergent vegetation, diversity and stature of emergent vegetation.

Riparian habitat quantity/quality: Length and width of riparian forest distance between suitable patches of habitat, successional stage, species diversity, ratio of degraded to high quality riparian habitat.

Shallow water aquatic habitat: benthic species diversity, areal extent or volume of habitat, diving bird abundance, quantity of chlorophyll a, seasonal salinity variance.

Other aquatic habitat indicators: location of X2, salinity gradient, net freshwater inflow and outflow, San Joaquin River flow, Sacramento River flow, Delta outflow, water depth, velocity, and substrate.

Food Web Indicators: chlorophyll a, phytoplankton (marine neritic diatoms, Melosira), rotifers, copepods (Eurytemora, Acartia), cladocera (Daphnia, Bosmina), and shrimp (Crangon, Neomysis).

Inhibitors: BOD, water hyacinth, Asian clams, boat traffic, agricultural drains, water diversions/intakes, fish predators, wildlife predators, and toxic chemicals.

Community assemblage: healthy assemblage of native fishes, lack of many exotics species.

Population indicators: species presence/absence; density, birthrate, growth rate, mortality rates, productivity/ reproductive rate; age distribution, population dispersion/distribution, population size, and harvest rates.

Individual indicators: growth rates, disease/parasites factors, fecundity, condition, diet and food uptake.

CALFED BAY-DELTA ECOSYSTEM RESTORATION PROGRAM DEFINITIONS

THE ECOSYSTEM RESTORATION PROGRAM GOAL: Improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species.

Objective: a desirable function or condition of the Bay-Delta system that the Program will strive to maintain or achieve. The three objectives in the Program are listed in the "Ecosystem Restoration Strategy" section of this packet.

Example: *Improve and Increase Aquatic Habitats so that they can support the sustainable production and survival of native and other desirable estuarine and anadromous fish in the estuary.*

Subobjective: An Ecosystem Restoration Program Subobjective provides an additional level of delineation in support of the objective. The eighteen sub-objectives are also listed in the "Ecosystem Restoration Strategy"section of this packet.

Example: *Increase Amount of High Quality Shaded Riverine Habitat to allow the growth and survival of sustainable populations of estuarine resident and anadromous fish in the estuary.*

a) *Increase Amount of Quality Riparian Woodland Habitat to allow production of terrestrial food sufficient to support sustainable populations of resident and anadromous fish.*

b) *Increase Amount of Large, Woody Debris along Delta levees to allow juvenile and adult feeding and refuge for sustainable populations of fish.*

c) *Increase Amount of Shaded Riverine Habitat to provide for localized temperature reduction.*

Implementation Objective: the most specific and detailed description of a function or condition that the Program will strive to maintain or achieve. An implementation objective is the end point in a hierarchy of Program objectives. It may be site-specific or associated with an ecosystem function or species.

Example: A CALFED implementation objective for Sacramento River habitat restoration might be to maintain or restore streamside riparian vegetation.

(Note: The goal objectives, sub-objectives, and implementation objectives are not intended to change during the life of the Ecosystem Restoration Program.)

Target: a quantified expression of a implementation objective. The quantification may be numerical or narrative. In some cases, we do not yet have sufficient information to set targets.

Example: A CALFED target for Sacramento River habitat restoration might be to obtain streambank or riparian zone conservation easements to protect at least two river miles in a particular area.

Action: a physical, operational, legal, or institutional change intended to maintain or achieve a desirable function or condition of the Bay-Delta system.

Example: A CALFED action could be the purchase of a conservation easement along the bank of the Sacramento River between river miles 270 and 276.

Ecological Indicator: an attribute of the Bay-Delta system that can be measured to gauge our success in maintaining or achieving desirable functions or conditions.

Example: A CALFED ecological indicator could be the total miles of riparian zones or the annual net increase in acreage.

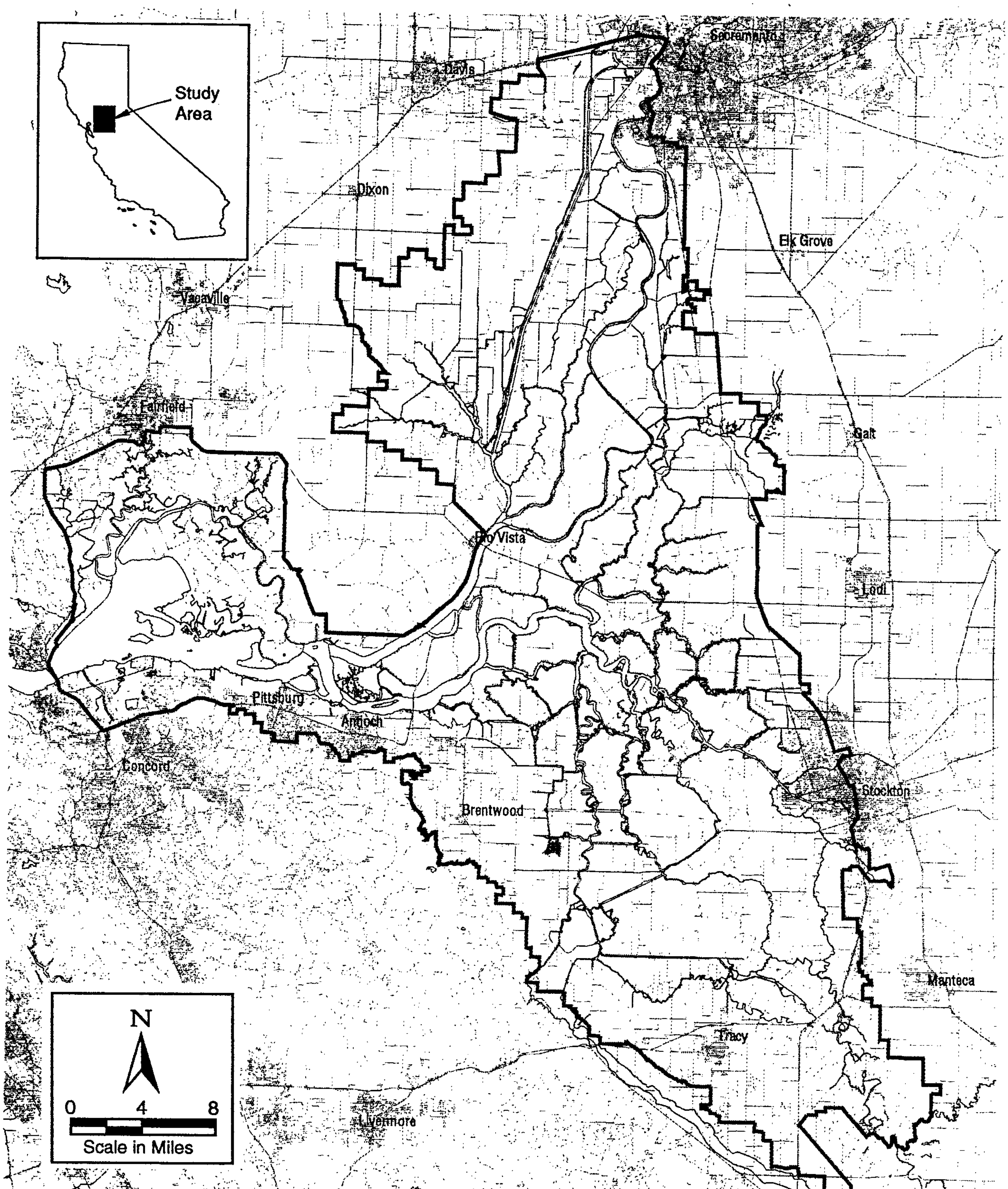
(Note: targets, actions, and ecological indicators may change during the program.)

CALFED ECOSYSTEM RESTORATION PLANNING AREA

Consistent with the CALFED Bay-Delta Program's Geographic Scope, the ecosystem restoration planning area has both a problem area and a solution area. The geographic area for defining ecosystem quality problems consists of the legally defined Delta, Suisun Bay (extending to the Carquinez Straight), and Suisun Marsh (Figure 1). This is identical to the problem geographic scope defined for the overall CALFED Bay-Delta Program. As with the overall CALFED Program, the Ecosystem Restoration Common Program will address ecosystem quality problems which are manifest in or closely linked to the Delta and to the Suisun Bay/Suisun Marsh areas.

The solution area delineated by the Ecosystem Restoration Common Program is expected to provide solutions to most of the identified problems (Figure 2). The area includes the watershed of the Central Valley Basin and the San Francisco Bay. Although not specifically delineated on this map, solutions may also be found in the near shore area of the Pacific Ocean. This solution area is smaller and a subset of the solution scope identified for the entire CALFED Bay-Delta Program.

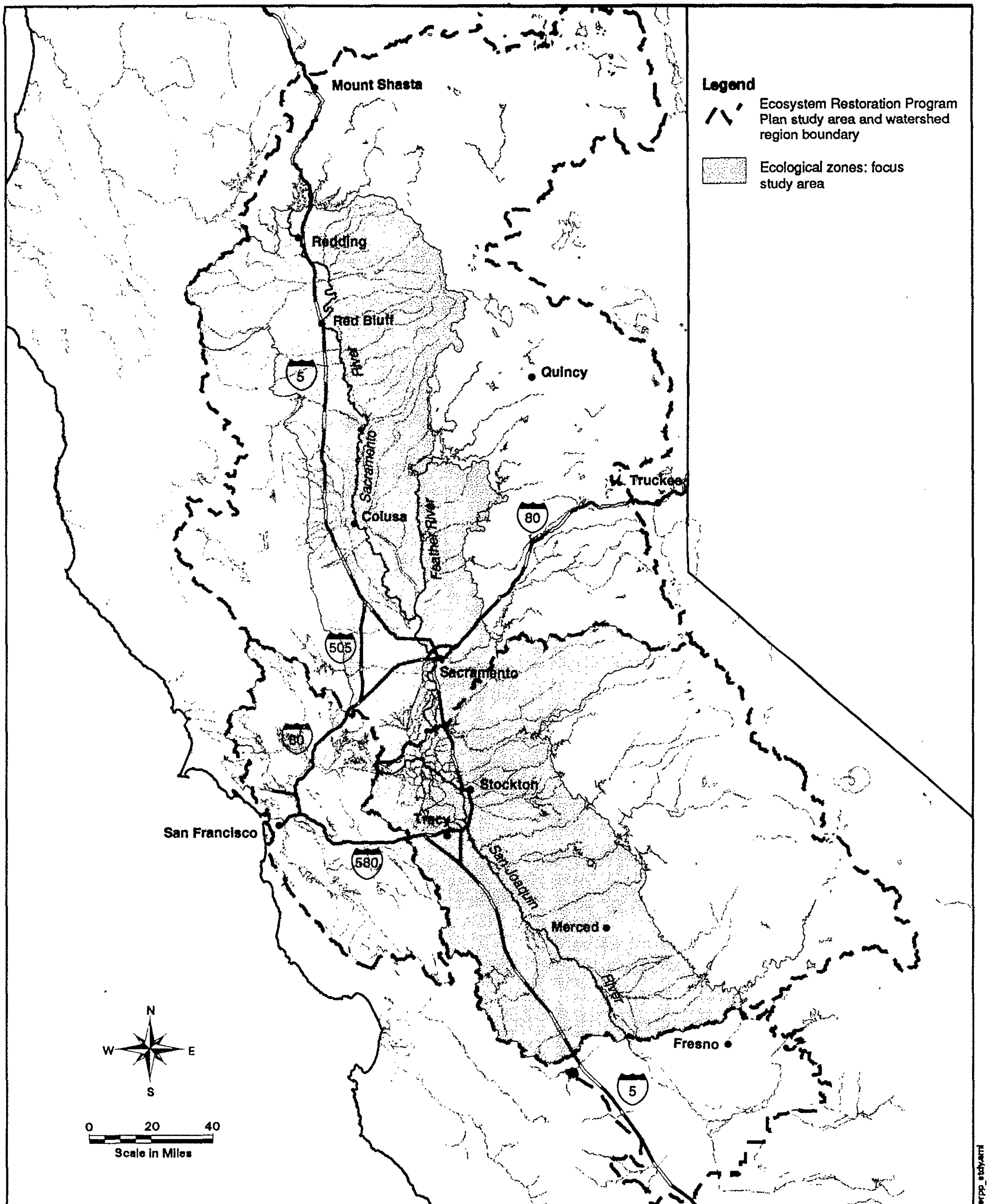
Figure 3 depicts the ecological zones or units for managing the planning process. The sum of these 36 units comprises the focus study area for the ecosystem restoration planning effort and the area where actions would result in a likely improvement in ecosystem health. The focus study area is the area where most of the direct impacts to ecosystem functions and processes has occurred and the area where species dependent on the Bay-Delta system spend an important part of their life cycle. There may also be opportunities to develop solutions outside of the focus study area but still within the solution area. An example would be watershed improvements above dams. Watershed management could restore a more natural flow regime or improve water quality. For this reason, the figures include a delineation of the watershed boundaries as part of the solution areas.



CALFED
BAY-DELTA
PROGRAM

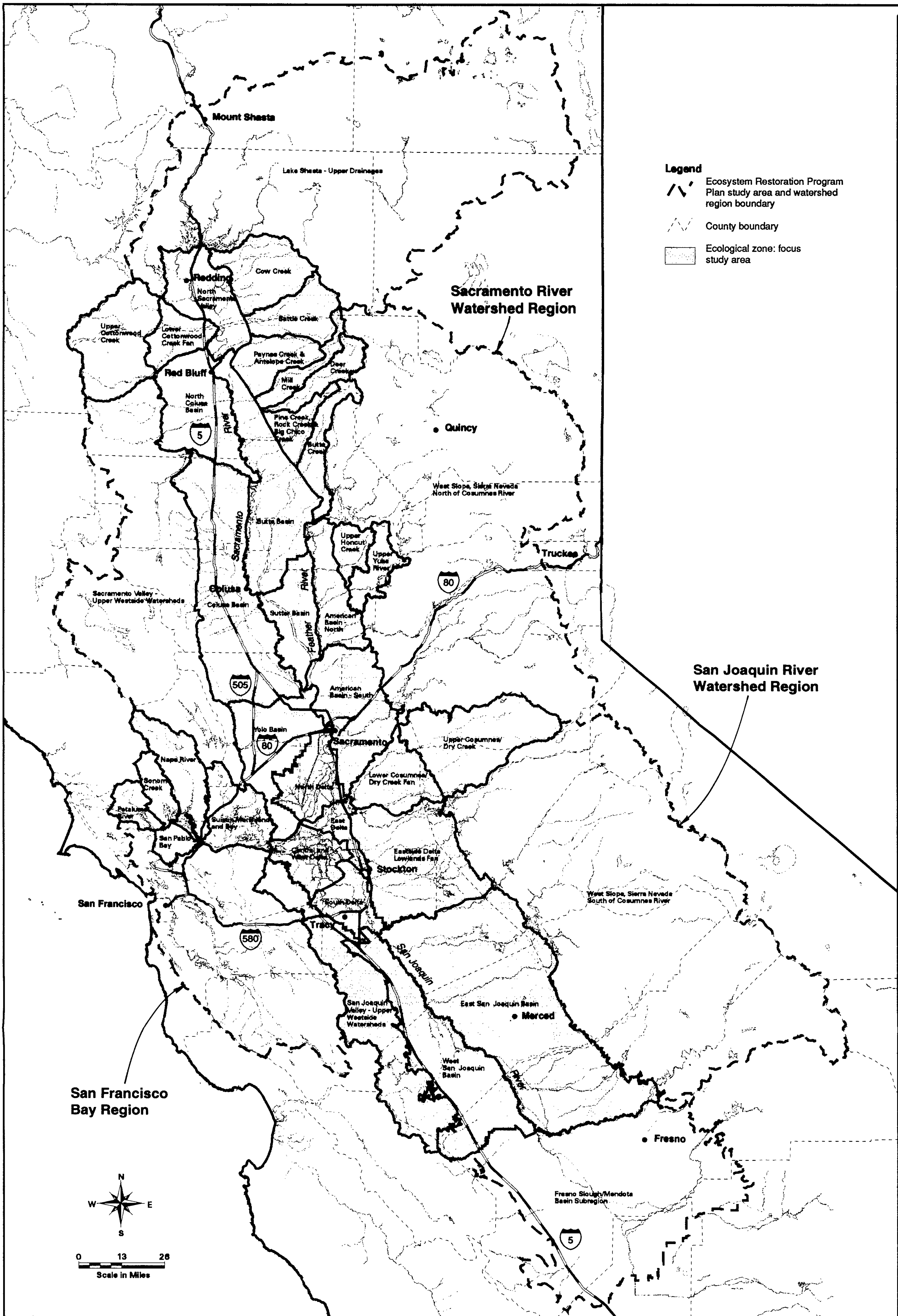
Figure 1
Problem Scope

D-026049



CALFED BAY-DELTA PROGRAM

Figure 2
Solution Scope



CALFED BAY-DELTA PROGRAM

Figure 3
Ecosystem Restoration Program Plan Study Area and Ecological Zones : Area Zones

TARGETS DEVELOPMENT PROCESS

ESTABLISHING IMPLEMENTATION OBJECTIVES AND TARGETS

INTRODUCTION

Establishing a quantitative vision of ecosystem health for an ecosystem as complex and as altered as the Bay-Delta will be difficult. Historical population related targets may be difficult to achieve in a system reduced in size by dams and affected by introduced species. Functional goals based on geological, chemical, and biological processes are limited by human intrusion and the demands for economic production, public health and safety, and recreation. Selection of a percentage of habitat acreage or ecological function available at some historical period, may have little meaning without population data to support the vision. A reference system would provide a natural model to guide our decision, but an undisturbed ecosystem with the complexity and variability of the Bay-Delta system does not exist. Existing restoration programs provide some guidance, but to date we have not found any restoration effort with the scope and complexity of ours, or degree of conflict that must be resolved.

The following describes three general approaches that may be used to develop implementation objectives and targets. These three methods include: 1) reconstruct a historical pre-disturbance perspective; 2) use diagnostic and prescriptive indicators for aggressive adaptive management; and 3) use a historical reference period incorporating existing disturbances. By discussing the strengths and weaknesses of these approaches it is anticipated that we can utilize the best features of each in developing implementation objectives.

HISTORICAL PRE-DISTURBANCE PERSPECTIVE

The goal of this approach is the restoration of ecosystem "health" and the restoration of structural elements, functional organization, and species composition comparable to the historic natural habitat in diversity, resilience to stress and sustainability.

The objectives should be specific, desired, qualitatively or quantitatively defined ecological conditions characteristic of a "healthy ecosystem." These include restoration of native species biodiversity, diversity of natural habitat types, natural production of valuable species and habitats for harvest and recreation, natural hydrological patterns, natural trophic structure, natural patterns of transport of essential elements (nutrients, sediments, etc.), and water quality. A reference condition or set of reference conditions should be used to establish minimum objectives, for example, restoration of no less than 25 percent of pre-disturbance habitat acreage; biodiversity or access to habitat equivalent to a period when fish and wildlife species were abundant and widely distributed.

The targets should be high-resolution, quantitative objectives. All targets should meet threshold criteria for habitat quantity and quality (e.g. areal extent or magnitude of flow, geographic distribution, minimum patch size, connectivity, diversity of habitat type, use by different species and by different life history stages of individual species, duration and timing, effects of inter- and intra-annual variability).

Targets should be achieved in three phases: 1) completion of program arrangements necessary to achieve targets; 2) specified milestones toward full achievement; and 3) attainment of desired ecological condition.

Specified milestones should be achieved in a 5-10 year period. These targets are to: 1) recover and maintain native species biodiversity, especially viable populations of estuary-dependent native plant and animal species of concern; and
2) support natural production of valuable fish and wildlife species for sustainable recreational and commercial harvest.

Attainment of desired ecological conditions should be achieved in a 5-30 year period. These targets are to recover and maintain: 1) natural Bay-Delta ecosystem dynamics (habitat mosaic, hydrological patterns, etc.) at the ecosystem level, within each ecological zone, and throughout each habitat type; and 2) complex biological communities favoring native species biodiversity.

DIAGNOSTIC AND PRESCRIPTIVE INDICATORS

As a result of various workshops and discussions over the last year, the following restoration framework has also been proposed.

Step 1. Identify the products of the ecosystem that are not adequately being produced. These might range from such mundane products as non-toxic sportfish harvest rates per angler hour and sustainable commercial harvest tonnage, to more esoteric issues such as assurance of continued existence of native fishes or satisfaction of voters generally with the Delta aquatic environment. Loosely speaking, these are the "goals" of ecosystem restoration and as addressed by many participants at the early CALFED public workshops. *In the human health analogy these correspond to a recounting of aches and pains.*

Step 2. For each of the products identified in Step 1, develop a measurable, scientific parameter that corresponds to the goals of Step 1, but which cannot be directly manipulated. Thus, one would not use "catch rates of striped bass" because that could be achieved by restricting the number of fishing licenses. An appropriate metric might be something like "natural production of 3 year-old striped bass." These parameters will reflect the natural processes that lead to the desired products and should be derived through the knowledge and professional opinions of biologists and engineers. These refined goals are the "diagnostic goals." *These are diagnostic* *for the ecosystem like a medical doctor might translate a patient's sore knee into a measure of joint strength and mobility.*

Step 3. Develop relationship equations for each of the "diagnostic goals" and parameters that are affected by human action. This will necessitate the use of life-cycle models and multi-parameter analyses to identify likely controlling factors. The biologically important parameters that affect biological resources, and *can be manipulated by humans*, comprise the list of possible CALFED "actions." This is the stage at which "science" comes into the planning process.

In many cases this step will require the construction of intermediate steps (perhaps production of young-of-year fish, survival to 1 year, survival to 2, survival to 3), and the regression lines will not be significant due to the restricted amount of data available. In some cases, biological opinions will be the only basis for assessing a relationship. However, this analysis will produce useful guidance:

1. What are the most likely *controllable* factors?

2. Which controllable factors are most likely to result in changes in the diagnostic variable? (i.e. which factors maximize controllability and effectiveness?)

3. Which management actions are the most effective in affecting the diagnostic goal? (i.e. what is the bang for the buck?)

4. Which studies or adaptive management strategies are possible to improve our understanding of the relationship? (i.e. what is the feasibility on smaller scales).

Also, at this stage, it will be necessary to examine the extent to which actions associated with one goal are contradictory to the needs of another goal. Optimizing complementary actions to achieve all ecological goals is a functional and focused form of "ecosystem management." For example, striped bass hatcheries may be highly effective in producing striped bass but possibly negatively affect restoration of other species. Restoration of high habitat diversity is probably less apt to produce conflicting results for the various goals. *In human health these correspond to the identification of treatment options - palpating the joints, reviewing the patient's recent activities and genetic predispositions, and consulting outside specialists. Steps 3 and 4 might correspond to experimental treatment and exploratory surgery.*

Step 4. Set the level of CALFED actions consistent with achievement of a first phase of restoring the function measured by the diagnostic indicator; this level of action is the "prescriptive goal." By setting different levels in different areas, or by addressing one type of action in one part of the estuary and a different level in another, CALFED can begin a series of adaptive management efforts that will result in the maximum effectiveness of later restoration actions by addressing a diversity of efforts in early stages. *Concluding the human analogy, as soon as possible the patient needs to receive treatments that can reasonably be expected to cure his aches and pains, although it may be most effective in the long run to use one treatment on one knee and something else on the other in order to provide the information needed for the best long term solution. Identifying the best long-term treatment will be done by reference to the diagnostic measures of joint strength and mobility.*

The use of "diagnostic" and "prescriptive" clarifies what we are trying to achieve. All participants might agree that ecosystem products should be aimed at some historical level. Confusion stems from thinking that the prescriptive actions should also be related to historical conditions.

Despite what some participants have said, it is irrelevant whether a particular functional relationship between a goal and an action was compromised. Particularly in regard to habitat efforts, we lack any usable quantification of the relationship of habitat diversity and fish abundance, survival or distribution. However, the slope of the relationship may be steeper and apply to more ecosystem products than any other single action. Thus, to get the same level of ecosystem response as we would get from $1 billion of habitat restoration might require $5 billion of water project impacts or $10 billion to construct hatcheries for all species of interest. Thus, cost effectiveness is a more appropriate criterion for CALFED priorities than focussing only on recent impacts.

HISTORICAL REFERENCE PERIOD

A qualitative vision may be a way to achieve our needs. There have been points in time when professionals and the lay public considered the health and productivity of the ecosystem to be in balance with the unavoidable demands of society, and there is some precedent for this approach.

The EPA selected the late 1960's through early 1970's as a time when the X2 or mixing zone of the Delta was in a near optimal location. The North American Waterfowl Habitat Management Plan used the acreage of wetlands and the amount of waste grain necessary to support the average wintering waterfowl population present from 1970-79 to establish its goals. Anadromous fisheries proponents used the average populations from 1967-91 to set the "doubling goal" for the Central Valley Project Improvement Act. The Department of Fish and Game has used "recent historical levels" to set its goal for striped bass population levels. In each of these examples, and there may be others, there apparently was an understanding, or the perception, that some important component of the ecosystem was healthy.

CONCLUSION

Some hybrid of quantitative targets and qualitative implementation objectives may be best for the CALFED Bay-Delta Program. We can select a reference period when no species was known to be threatened with extinction, when chinook salmon and striped bass supported both quality sport fisheries and a stable commercial harvest, and when migratory and resident wildlife were abundant. The reference period could serve to set population targets and many of our habitat goals.

For our qualitative implementation objectives we need to look both at reference periods and at limiting factors or stressors. Unscreened diversions have limited the productivity of our fisheries since the 1800's. The level of pollution in the 1960's was unacceptably high, even though fish and wildlife populations were relatively healthy. Some limiting factors or stressors must be addressed independent of their presence or absence during the selected reference period. Some problems, such as those associated with some exotic species cannot be eliminated. In these cases we will have to compensate for their impacts of providing some conditions which are more productive than the reference period.

TARGET-SETTING EXAMPLES

The complete ecosystem restoration program may contain hundreds of specific targets. In every case, the targets will relate directly to the ecosystem problems that have been identified, as well as to the ecosystem common program goal, objectives, and subobjectives adopted during Phase I of the Bay-Delta Program. During Phase II, implementation objectives have been developed to add specificity to the subobjectives so that meaningful targets could be developed.

The seven example targets described below are presented with their related objective and subobjective to show the relationship. Every example is also related to the Program's mission and ecosystem restoration program goal:

> **Program Mission:** The mission of the CALFED Bay-Delta Program is to develop a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta System.
>
> **Ecosystem Restoration Program Goal:** Improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species.

The first four example targets are for the **North Delta Ecological Unit**. The examples describe targets and actions designed to restore a habitat type, restore an ecosystem function, reduce the impact of an environmental stressor, and meet the needs of an assembly of species.

The last three example targets are for the **American River Ecological Unit**. In terms of geographic scope, this is outside the Program's problem area but within the solution area. Actions implemented in the solution area--in this case upstream of the Delta--can help to solve problems that are manifest in the Program's problem area. Among these American River examples, one is provided for each of the three primary ecosystem quality objectives. These relate to improving aquatic habitat, improving wetland habitat, and increasing the size and health of populations of important species.

EXAMPLE 1 -- HABITAT TYPE

Objective: Improve and increase important wetland habitats so they can support the sustainable production and survival of wildlife species.

Subobjective: Increase the amount of high quality freshwater marsh habitat to better support sustainable populations of native wildlife species in the Delta

Implementation Objective: Increase the acreage of tidal, shallow, perennial, wetland habitat in the North Delta Ecological Unit to the amount existent in 1967.

Targets:

(a) Restore or recreate 2,000 acres of tidal, shallow, perennial wetland habitat in the near term.

(b) Restore or recreate a total of 6,000 acres of tidal, shallow, perennial wetland habitat over the long-term.

Target Rationale: *Prior to development, most of the Delta was perennial wetland. These wetlands provided ecological functions critical to the health of the system. These included nutrient cycling, nesting, spawning and rearing habitat, escape cover, foraging areas, and attenuation of flood flows. Historical topographic maps and aerial photographs indicate a steady and substantial decline of this habitat type throughout the Delta. Restoration of this habitat type is limited to areas where land surface elevation is less than six feet below sea level at mean high tide. The North American Waterfowl Habitat Management Plan recommends restoration of wetlands in the Delta to a total of 19,500 acres. That figure is based on the acres of managed freshwater marsh needed to support the average wintering waterfowl population found in the Delta during the late 1960's and early 1970's. The target would serve the dual purpose of providing waterfowl and fisheries habitat.*

Action: Acquire in fee or obtain conservation easements on appropriate lands in the North Delta Ecological unit. Restore suitable topography and open to tidal action.

Adaptive Management/Monitoring: The plants which colonize newly restored tidal habitat areas will vary as a function of soil type, depth of tidal waters, salinity and a number of other factors. The target for near team restoration will allow for evaluation in the field. Several distinct sites would be used for the evaluation. The results of the monitoring and evaluation could result in changes in design, location or target acreage.

EXAMPLE 2 -- ECOLOGICAL FUNCTION

Objective: Improve and increase important wetland habitats so they can support the sustainable production and survival of wildlife species.

Subobjective: Increase the amount of high quality riparian woodland habitat in the Delta to better support sustainable populations of native wildlife populations.

Implementation Objective: Increase the acreage seasonally flooded by the Cosumnes River within the North Delta Ecological Unit.

Target: Increase sediment transport from the flood plain to the North Delta by ten percent to support successional stage riparian vegetation.

Target Rationale: *Sediment transport, deposition and erosion is an ecological process critical to many ecological biological and geological functions. In the North Delta Ecological Unit this process has been constrained by levee construction. The implementation objective to increase this process by ten percent is a conservative first step which will provide valuable habitat and insight. The habitat resulting from the action will be early successional stage riparian and the insight to be gained from monitoring will help us to evaluate the effectiveness of restoring a natural process in a natural manner. Some experimentation with this action has taken place on the Cosumnes River Preserve and the results are very promising.*

Action: Acquire 1200 acres riparian to the lower Cosumnes River and breach levees which prevent seasonal flooding.

Adaptive Management/Monitoring: Geofluvial processes such as erosion, deposition, and transport can be measured and monitored. If deposition areas become isolated or armored by vegetation, they can be physically altered or dedicated to the riparian habitat targets account and additional acreage could be acquired.

EXAMPLE 3 -- ECOSYSTEM STRESSOR

Objective: Increase population health and population size of Delta species to levels that assure sustained survival.

Subobjective: Increase populations of economically important species.

Implementation Objective: Increase the survival of juvenile salmon migrating through the North Delta Ecological Unit.

Target: Screen 50 percent of the water, by volume, diverted in the North Delta Ecological Unit.

Target Rationale: *Direct mortality caused by unscreened diversions is a known stressor. The Department of Fish and Game, and the U. S. Fish and Wildlife Service have recommended screening all diversions which stress anadromous fish. Fish screens are also important to the recovery of resident Delta fishes. Fish screens in tidal areas are expensive and difficult to maintain. Screening 50 percent of the volume of water diverted would provide sufficient information to make decisions on future options. One option could be to focus on diversion site consolidation in conjunction with levee reconstruction.*

Action: Consolidate points of diversion and install positive barrier fish screens on all diversions over 50 cfs in the North Delta Ecological Unit to a cumulative total of 50 percent of the permitted diversion.

Adaptive Management/Monitoring: Tag and recapture methods can be used to assess the benefits of individual fish screens at this level. Evaluations of screen efficiency, increases in spawning recruitment and population increases could validate the sufficiency of the action or the need for change.

EXAMPLE 4 -- SPECIES OR ASSEMBLAGE OF SPECIES
Neotropical Migratory Bird Guild

Objective: Improve and increase important wetland habitats so they can support the sustainable production and survival of wildlife species.

Subobjective: Increase the amount of high quality riparian woodland habitat in the Delta to better support sustainable populations of native wildlife populations.

Implementation Objective: Restore and increase the acreage of valley foothill riparian and valley oak woodland habitat.

Targets:
(a) Restore 500 acres of valley foothill riparian forest in the North Delta Ecological Unit.

(b) Restore 1,000 acres of oak woodland forest in the North Delta Ecological Unit.

Target Rationale: *Prior to disturbance, riparian forests and oak woodland forests were an important component of the mosaic of habitats in the North Delta Ecological Unit. Their loss is an important factor in the decline of the endangered Swainson's hawk. Efforts to restore these types of habitat are underway at the Cosumnes River Preserve which is part of the North Delta Ecological Unit. Recommendations for this implementation objective and target are contained in the Swainson's hawk recovery plan being developed by Department of Fish and Game and the Riparian Habitat Joint Venture Plan being prepared by a multi-agency and stakeholder group headed by the Resources Agency. This acreage in this target is a "place holder" pending the completion of these plans.*

EXAMPLE 5 -- AQUATIC HABITAT

Objective: Improve and increase aquatic habitats so that they can support the sustainable production and survival of native and other desirable estuarine and anadromous fish in the estuary.

Subobjective: Increase amount of high quality shallow riverine habitat to allow sustainable fish spawning and early rearing.

Implementation Objective: Restore gravel recruitment process in the American River.

Target: Replenish spawning gravel between Nimbus Dam and Sailor Bar.

Target Rationale: *This target replicates an ecological process that was disturbed by gold mining and virtually eliminated by dam construction. There is no practical means to reestablish the process naturally, but by using hydrologic events to distribute the gravel, we can replicate that portion of the natural process. The likely result will be improvement of natural spawning by salmonid fish species and reduced stranding of young fish in pools and pockets when flows recede. The need to restore and replenish spawning gravel is identified in the Department of Fish and Game report, "Central Valley Action Plan," the DFG "Steelhead Management Plan," and the U.S. Fish and Wildlife Service "Anadromous Fish Restoration Plan." The placement of 10,000 tons of gravel containing tracer gravel is a manageable start to what would have to be an ongoing effort.*

Action: Place up to 10,000 tons of clean, appropriately sized spawning gravel at sites along the streambank for natural distribution during high flow events.

Adaptive Management/Monitoring: The flow level to mobilize and distribute spawning gravel is uncertain, but may only recur at 2-5 year intervals. The first phase of this program is to determine the flow necessary to transport and redeposit spawning gravel. This determination can be made during a natural hydrologic event, or flow could be augmented by supplemental release from Nimbus Dam for a 1-2 day interval. Following distribution of the gravel, stream surveys would be conducted to determine the downstream extent of the transport. This can be facilitated by the addition of tracer gravel to the supply. If gravel transport and redistribution is found to be satisfactory, then gravel quality and quantity would be annually monitored to determine when additional gravel addition and natural relocation would be beneficial. Use of the gravel by chinook salmon spawners would be monitored each fall during the annual chinook salmon spawning stock survey program to determine the extent to which the new gravel is used.

EXAMPLE 6 -- WETLAND HABITAT

Objective: Improve and increase important wetland habitats so that they can support the sustainable production and survival of wildlife species.

Subobjective: Increase the amount of high quality freshwater marsh habitat to better support sustainable populations of native wildlife species in the Delta.

Implementation Objective: Increase the quality and extent of freshwater marsh habitat in the American River ecological unit.

Target: Provide permanently flooded freshwater marsh habitat in the lower American River floodway.

Target Rationale: *This target is an example of a hybrid approach to target-setting. Prior to disturbance much of the lower American River flood plain was a seasonal or permanent marsh. One of the stressors affecting the survival and growth of young fish in the American River is the lack of sufficient rearing habitat. Development in the floodplain, parks, gravel extraction, and urban encroachment, all of which have increased since the 1960's, have combined to cause loss of this habitat.*

The recommendation for improvement and increases in this type of habitat were made by the Sacramento Area Water Forum, Department of Fish and Game, U. S. Fish and Wildlife Service, and the Lower American River Task Force. The level of this specific action is a portion of a larger target which will be developed by the CALFED Bay-Delta Program in collaboration with the other ongoing efforts.

Action: Establish a Bushy Lake freshwater marsh of 10-25 acres with year round connection to the American River and fed by a continuous flow of 5 cfs.

Adaptive Management/Monitoring: Bushy Lake has the potential to be managed as a permanent marsh with year round connection to the American River. The benefit of modifying Bushy Lake would be evaluated by annual biological monitoring of terrestrial, avian, amphibian, fish, and invertebrate species using the area, and determinations of annual relative abundance and abundance trends. Marsh morphology and presence and extent of emergent and riparian vegetation could be mapped in year one of the project to establish a baseline for future comparisons.

EXAMPLE 7 -- IMPORTANT SPECIES

Objective: Increase population health and population size of Delta species to levels that assure sustained survival.

Subobjective: Contribute to the recovery of threatened, endangered or species of special concern.

Implementation Objective: Increase the naturally produced steelhead trout population of the American River.

Target: Reduce or eliminate the harvest of American River naturally produced steelhead trout.

Target Rationale: *A stressor that has been identified as potentially limiting the production and survival of steelhead trout on the Lower American River is harvest. Because the steelhead trout population is augmented with hatchery fish, it is not practical to document the problem or to make an accurate diagnosis of the effects of harvest. Marking the hatchery fish will make this diagnosis possible and the appropriate action could be employed.*

Action: Implement a program to apply identifying marks to all steelhead produced at Nimbus Hatchery on the American River and implement an angling regulation requiring the release of unmarked steelhead, **or,**

Action: Eliminate the harvest of all steelhead trout in the American River to protect naturally produced fish, **or,**

Action: Establish a regulation that allows only a catch-and-release fishery for all steelhead in the American River to protect naturally produced fish.

Adaptive Management/Monitoring: A method to protect and restore naturally spawning steelhead trout in the American River is to mark all artificially produced steelhead prior to their release from Nimbus Hatchery. The marking program must be implemented for a minimum of three years prior to implementing a selective fishery for steelhead in the American River. This is to allow time for three consecutive year classes to receive the identifying mark so that the majority of adult hatchery steelhead returning to the American River are marked. Needed monitoring would include examination of all steelhead returning to Nimbus Hatchery for the presence or absence of the identifying mark, a creel survey to examine the angler harvest of steelhead, and a steelhead spawning stock survey to observe naturally spawning steelhead. The results of this information will be used to determine if a naturally spawning stock coexists with the hatchery stock or whether there is only a single stock, and whether the naturally spawning stock is being adequately protected by the selective fishery.

APPENDICES

Appendix A	Ecosystem Quality Problems
Appendix B	Adaptive Management in the CALFED Ecosystem Restoration Program
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APPENDIX A

Ecosystem Quality Problems

March, 1996

Many of the plant and animal species that use the Bay-Delta have experienced moderate to severe declines. The Bay-Delta ecosystem does not now contain the amount or quality of habitat needed to support a diverse assemblage of valuable plant and animal species. The major problems for the Bay-Delta's fish and wildlife and the aquatic and wetland habitats that support them are outlined below. Important species of fish, animals, plants, and other life-forms are identified in the problem statements as examples of the organisms adversely affected by the named habitat problems.

A. **Important Aquatic Habitats** are inadequate to support production and survival of native and other desirable estuarine and anadromous fish in the Bay-Delta system. Examples of fishes that have experienced declines related to changes in Delta habitat include delta smelt, longfin smelt, Sacramento splittail, chinook salmon, striped bass, and American shad. The problems for specific aquatic habitats include:

1. **Lack of Shallow Riverine Habitat** limits spawning success and early survival of many estuarine and anadromous fish in the estuary. Examples of affected species include Sacramento splittail, chinook salmon, striped bass, delta smelt, and American shad.

    a. **Lack of Riverine Edge Habitats** limits spawning success and survival of juveniles of many fish species that use such habitats for spawning and rearing (e.g. Sacramento splittail, delta smelt, largemouth bass, and chinook salmon).

    b. **Lack of Shallow Shoal Habitat** within the main channels of the Delta and upper Bay limits shallow foraging habitat and protective cover for juveniles of many estuarine fish (e.g. Sacramento splittail, striped bass, delta smelt, longfin smelt, starry flounder, and white sturgeon).

2. **Lack of Shaded Riverine Habitat** limits growth and survival of estuarine resident and anadromous fish in the estuary (e.g. Sacramento splittail, chinook salmon, and tule perch).

    a. **Lack of Riparian Woodland** limits cover and terrestrial food production for Delta fish.

b. **Lack of Large, Woody Debris** along Delta levees limits feeding and refuge habitat for juvenile and adult fish in the Delta.

c. **Lack of Shaded Habitat** results in elevated water temperatures.

3. **Reduced Quality of Tidal Slough Habitat** limits the aquatic resource production capacity of the Delta (e.g. delta smelt, chinook salmon, striped bass, Sacramento splittail, tule perch, and copepods).

a. **Degradation of Dead-End Slough Habitat** reduces areas available for spawning and rearing of some native resident fish species.

b. **Abundant Water Hyacinth** may limit productivity of tidal slough habitats.

c. **Primary Biological Production** during tidal cycling is limited by lack of tidal slough habitat.

4. **Springtime Upstream Relocation of Estuary Entrapment/Null Zone Habitat** by low Delta outflow limits the availability of suitable rearing habitat in the estuary (e.g. delta smelt, longfin smelt, and striped bass).

a. **Saltwater Intrusion into Suisun Bay** reduces the Bay's value as a low-salinity nursery area.

b. **Low Salinity (less than 10 ppt) Habitat** is confined to deeper channels in the Western Delta where it is of limited value as compared to Suisun Bay.

c. **Brackish Water (1 to 25 ppt) Habitat** occurs less frequently in San Pablo Bay with reductions in Delta outflow during the winter and spring which may limit production of bay species such as bay shrimp, starry flounder, Pacific herring, and dungeness crab.

5. **Reduced and Altered Transport Flows** hinder successful movement of larval and juvenile fish from spawning habitats to nursery habitats in the Delta and Bay (e.g. longfin smelt, striped bass, chinook salmon, and Sacramento splittail).

a. **Reduced Transport of Young Fish from the Delta to Suisun Bay** nursery areas because of low Delta outflow reduces growth, survival, and abundance of important estuarine fish (e.g. striped bass and delta smelt).

b. **Reduced Transport of Young Fish through the Delta** to the ocean limits survival and abundance of estuarine and anadromous fish (e.g. chinook salmon, steelhead, and American shad).

c. **Increased Transport of Young Fish from North to South across the Delta** and direct entrainment of fish because of high export-to-inflow ratios reduces survival and abundance of estuarine and anadromous fish (e.g. chinook salmon, delta smelt, striped bass, steelhead, and American shad).

d. **Local Structures** block and alter transport flows and increase predation rates (e.g. chinook salmon).

6. **Altered Migratory Cues** disrupt upstream and downstream movement of anadromous and estuarine fish (e.g. chinook salmon, steelhead, and white sturgeon).

a. **Upstream Migration of Adult Salmonids through the Delta is Disrupted** by lack of olfactory cues caused by export of spawning-river water in and above the Delta.

b. **Outmigration of Juvenile Fish through the Delta is Hindered** by net downstream flow cues toward South Delta export pumps (e.g. delta smelt, striped bass, American shad, and Sacramento splittail).

c. **Upstream Migration of Adult Estuarine Fish into Delta and River Spawning Areas is Hindered** by altered net flow of water across the Delta.

7. **Reduced Food Web Productivity** in aquatic habitats limits forage availability for fish species (e.g. delta smelt, longfin smelt, Sacramento splittail, chinook salmon, striped bass, starry flounder, bay shrimp, and neomysis).

a. **Entrainment of Food Productivity** by diversions limits habitat suitability for desirable fish species.

b. **High Concentrations of Toxicants** in the water column and in sediments reduces production and survival of aquatic plants and invertebrates.

c. **Introduced Species** compete for food and habitat space with desirable species.

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d. **Reduced Residence Time of Water** in Delta channels limits plankton blooms.

e. **Reduction in Nutrient Inputs** from wetland and riparian habitats limits aquatic productivity.

f. **High Salinity Levels** in Delta aquatic habitats limit seasonal productivity patterns of estuarine food-chain organisms.

g. **Reduction and Seasonal Shift of Freshwater Inflow to the Delta** directly limits primary and secondary productivity of the estuary during critical periods.

8. **Excessive Concentrations of Toxic Constituents and their Bioaccumulation** directly limits survival and growth of desirable fish, wildlife, and other species (e.g. delta smelt, longfin smelt, Sacramento splittail, chinook salmon, striped bass, starry flounder, rails, avocets, grebes).

a. **Excessive Pesticide Residues** directly affect some fish and wildlife species.

b. **Excessive Hydrocarbons, Heavy Metals, and other Pollutants** directly harm some fish and wildlife species.

B. **Important Wetland Habitats** are inadequate to support production and survival of wildlife species in the Bay-Delta system. The problems for the specific wetland habitats include:

1. **Lack of Brackish Tidal Marsh Habitats** of high quality limits supportable populations of wildlife species that inhabit them (e.g. Suisun Slough thistle, Suisun song sparrow, and snowy egret).

a. **Altered Vegetation Composition** in brackish marshes caused by changes in salinity levels limits habitat suitability for some species.

b. **Reduced Areal Extent and Patchiness** of brackish marsh limits wildlife populations and genetic exchange.

c. **Disconnection of Supporting Habitats** such as aquatic habitats and riparian woodlands and adjacent uplands limits productivity in brackish marshes.

2. **Lack of Freshwater Habitats** of high quality limits supportable populations of native plant and wildlife species (e.g. giant garter snake, tri-colored blackbird, and Mason's lilaeopsis).

   a. **Inappropriate Increased Salinity Levels** do not support desirable vegetation composition and thereby limit habitat suitability for some species.

   b. **Reduced Areal Extent** of high quality freshwater marsh habitats does not support sustainable population sizes of some wildlife species.

   c. **Lack of connection between** freshwater marsh habitats does not provide corridors for population movement and genetic exchange.

   d. **Vulnerability of Delta Islands to Levee Failure** threatens sustainability of existing freshwater marshes.

3. **Limited Riparian Woodland Habitats** of high quality in the Delta reduce diversity and sizes of supportable native wildlife populations (e.g. Swainson's hawk, riparian brush rabbit, western yellow-billed cuckoo, neotropical migrant songbirds, and northern California black walnut).

   a. **Lack of Riparian Habitat Structure** near foraging areas limits nesting opportunities for some native bird species.

   b. **Fragmentation** of riparian habitat does not provide corridors for population movement and genetic exchange.

   c. **Limited Areal Extent** of riparian habitats prevents use by some native bird species.

   d. **Disconnection of Supporting Habitats** such as aquatic habitats and brackish marshes limits productivity in riparian woodlands.

4. **Reduced Breeding Waterfowl Habitats** limit production of desired populations of dabbling ducks (e.g. mallard, cinnamon teal, and wood duck).

a. **Lack of Brood Habitat** of high quality near nesting habitat limits dabbling duck production.

b. **Lack of Nesting Habitat** of high quality near brood habitat limits dabbling duck production.

5. **Reduction in Wintering Wildlife Habitats** for foraging and resting limits desired populations of wintering waterfowl (e.g. Aleutian Canada goose, mallard, tundra swan, white-fronted goose and shore birds).

a. **Decreasing Waste Grain** on agricultural lands limits availability of wildlife forage.

b. **Lack of Resting Areas** near foraging areas limits wintering wildlife populations that can be supported in the Delta.

c. **Reduction in Historical Foraging Habitats** (e.g. freshwater marsh and brackish water marsh) limits availability of high quality foraging areas for wintering wildlife.

d. **Vulnerability of Delta Islands to Levee Failure** threatens sustainability of some wintering wildlife habitats.

6. **Lack of Managed Permanent Pasture Habitat** limits wintering crane populations (e.g. lesser sandhill crane, greater sandhill crane).

a. **Lack of Foraging Habitats** of high quality for cranes in proximity to roosting habitats limits supportable wintering populations.

b. **Lack of Roosting Habitats** of high quality for cranes in proximity to foraging habitats limits supportable wintering populations.

7. **Restricted Flood Plains and Associated Riparian Habitat** of sufficient size and high quality in the Delta reduce the diversity and sizes of fish and wildlife populations.

a. **Lack of Suitable Flood Plains** reduces the availability of temporarily flooded spawning habitat for fish such as the Sacramento splittail.

b. **Narrow Restricted Channels** increase the risk of levee failure and subsequent catastrophic losses of wildife habitat protected by these levees.

C. **Populations of some species of plants and animals** dependent on the Delta have declined.

1. **Many species in the Bay-Delta system** have declined to the point that they are threatened, endangered, or species of special concern.

2. **Many species of economic importance** that are dependent on the Bay-Delta system have declined.

3. **Some prey or food species** dependent on the Bay-Delta system have declined to the point that they no longer adequately support populations of predator species.

APPENDIX B

ADAPTIVE MANAGEMENT IN THE CALFED ECOSYSTEM RESTORATION PROGRAM

Ecosystem management is the process of taking actions to preserve, sustain, enhance, and restore ecological resources and provide for human needs in an ecosystem such as the Bay-Delta. Adaptive ecosystem management is adjusting this management process as the process unfolds and results are obtained (Holling 1978; Walters 1986; Lee 1993). It is an interactive approach to decision making. Adaptive management involves implementing the actions most likely to achieve ecosystem management goals, given today's knowledge. Experimental management is included where improved knowledge is essential. Results are monitored and actions modified as necessary to achieve management goals. In the ecosystem health vernacular, ecosystem managers diagnose, treat, monitor response to treatment, and then adjust the treatment as needed.

Adaptive management should involve stakeholders and resource managers working together in redirecting program actions in response to increasing ecological information (Holling 1978; Walters 1986; Walters and Holling 1990). Because of the difficulties and uncertainties involved in ecosystem management, adaptive management has been suggested and widely adopted as the standard approach to ecosystem management (Everett et al. 1994). Adaptive management is a key component of ecosystem management as it provides a decision support system for stakeholders and resource managers (Wondolleck 1988). Adaptive management addresses risks and uncertainties by increasing opportunities to redirect management with new information" (Everett et al. 1994)

To succeed an adaptive management program should include objectives for key resources, indicators, and actions with target implementation levels. Program objectives should be well defined, and should not be adjusted in the event success is not achieved; only targets and the implementation approach should be changed. The state of health the program hopes to achieve should not change, only the treatment program need be changed to ensure health goals are achieved. Targets may change as research and monitoring provide more indication as to the inherent relationships between indicators and key resources. Monitoring data are examined and reexamined with these objectives and targets in mind.

Effective adaptive management requires well-defined success criteria, long-term comprehensive monitoring plans, comprehensive restoration plans, and a cooperative management team.

NEED FOR ADAPTIVE MANAGEMENT

The primary need for adaptive management is to provide a process that maximizes the potential success of a restoration program. Adaptive management provides a process of actions, monitoring, evaluation, and readjustment that helps to insure program goals and objectives will be met. It provides for rapid feedback of information and adjustments in program actions and implementation levels to keep the program on track. Adaptive management helps in dealing with the inherent uncertainties of complex ecosystems. When causes of specific ailments are unknown and difficult to diagnose, then the solution may become evident from the response to treatments. Adaptive management provides needed feedback on the treatment regime and the amount of treatment required for restoration. In ecosystem restoration programs there are often questions of how much habitat is needed and to what extent it should be restored. Adaptive management provides for experiments and monitoring to address these questions. There may also be questions on techniques and engineering feasibility. Pilot studies and experiments can provide an arena in which to work out the technology bugs and refine the methods.

Adaptive management provides for flexibility in the restoration program. It allows a step by step approach where solutions can be implemented in phases for cost or technical reasons. Flexibility comes from the ability to adjust the program as needed.

Uncertainty

Uncertainty about the future can be addressed with adaptive management. Change is likely with increases in development, greater water diversions, changing land use, demographics, economy, and values. Weather and rainfall are also uncertain. Even such things as global warming with its accompanying sea rise are changes to be considered. Further invasions of exotic species are likely. Since we cannot be sure how such change will occur, we must adapt to the changes as they occur. Whether the future is chaotic or potentially predictable, adaptive management provides a solution.

Lack of sufficient knowledge about complex ecosystems such as the Bay-Delta brings uncertainty to a restoration program that can be alleviated through adaptive management. Specific hypotheses can be tested in experimental actions to further understanding of the underlying cause-and-effect mechanisms that control the target ecosystem. There may be many hypotheses to test before the program can proceed toward success. Probing into uncertainty with experiments should provide needed information. For the least understood problems, several treatments may be proposed, and responses monitored through key vital signs or indicators. More serious problems may require more aggressive or even experimental treatments.

There is also uncertainty relative to the potential benefit, costs and indirect effects of specific actions. Actions may fail to achieve objectives and there will be a need to shift direction to meet objectives. Technical feasibility may be in question for specific actions. Or we may not know how to implement an action. The potential effectiveness of specific actions may also be in question. Actions may also appear to be ineffective at a test scale, but be effective on a broader scale of implementation. A phased or experimental approach would allow some action to be directed toward problems before there is complete agreement on the overall solution. Diverse opinions may call for multiple approaches toward solving specific problems. An adaptive approach can also help to overcome uncertainties related to state, federal, and local restrictions and regulatory requirements by implementing programs incrementally.

The potential for risk or failure increases with uncertainty. Adaptive management is an effective tool to minimize risks in an ecosystem restoration program. Risks such as indirect effects of actions can be identified from test programs. For example, increasing flows in one season usually means decreasing flows in another. Testing programs can identify risks with minimal impacts. Irreversible negative impacts are minimized under an adaptive management approach. We should be particularly aware of actions that preclude future options. With stakes high and funding limited, adaptive management provides a cautious and potentially reversible approach. Management must balance uncertainty and risks of failure with risks of no action.

Testing and monitoring under adaptive management verify that implementation objectives and targets are being met and reveal indicators and targets remain appropriate representatives of the key resources and their goals.

Adaptive management provides opportunities to fund the program in stages. Commitments are often easier to obtain after each stage is proven successful and optimism builds for the next. Opportunities for cooperative funding or combining programs also come up that may improve the overall funding and potential success of the program. Unprofitable expenditures are limited. Costly long-term commitments that provide little or no benefit are avoided.

Adaptive management allows for periodic adjustments to ensure equitable use of resources. Staging of program implementation provides opportunities to monitor equity and make corrections.

Stakeholder Involvement

Adaptive management allows stakeholder involvement and helps avoid potential disagreements. It allows for consensus, and provides opportunities to contribute knowledge and resources to problems. It also provides opportunities for those involved to weigh risks and benefits of actions. Such balancing usually benefits from cooperative stakeholder involvement.

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POTENTIAL DRAWBACKS OF ADAPTIVE MANAGEMENT

There are several potential drawbacks of adaptive management.

- Small test efforts may not provide sufficient testing of the diversity of important ecosystem functions in a complex ecosystem such as the Bay-Delta.
- A phased approach may delay implementation and could allow declines in the health of important ecosystem components.
- Benefits of some aspects of the program may be a long time in coming or may not even be detectable, which may lead to dropping valuable program elements.
- Information and analytical needs of adaptive management are extensive, requiring large amounts of monitoring and research.
- Funding for an uncertain future and for the necessary monitoring and research may be difficult to obtain.
- Obtaining consensus and management direction and support on future modifications of actions may be difficult.

ADAPTIVE MANAGEMENT IN THE CALFED BAY-DELTA PROGRAM

The CALFED Bay-Delta Program has chosen to approach restoration of the Bay-Delta from an ecosystem perspective, because of the system's large size and complexity. The traditional piece-meal approach of addressing multiple local area restorations will not work in a large, complex, and integrated ecosystem such as the Bay-Delta and its upstream watersheds. This has been obvious to those involved with the Bay-Delta problems over the past several decades, and adaptive management has been a common practice at least at the individual project level. Previous efforts at adaptive management, such as the State Board standards process, usually had too narrow a focus to provide an ecosystem level of restoration. The CALFED program offers an opportunity to extend this approach to restoration of the ecosystem at the basin-wide level with a much broader focus.

The goal of the program is to prevent further deterioration of the Bay-Delta ecosystem and to restore as much of the ecosystem health as possible. Knowledge and funding are needed to accomplish this goal. However, since knowledge and funding are limited resources, adaptive management will maximize the efficiency and cost effectiveness of the effort.

Adaptive management is a necessity of the CALFED Bay-Delta Program, because of uncertainty about the causes of the ills of the Bay-Delta ecosystem and the inability to predict responses to proposed remedies and actions. A substantial number of the CALFED proposed actions will necessarily be implemented as "experiments" because of highly uncertain outcome and benefit. Actions are designed to meet specific objectives, but responses may be uncertain. For example, identified declines in many fish populations have been related to a combination of diverse factors with the cause-and-effect mechanisms and roles of each factor being relatively unknown. Fish declines coincide with changes in flow and habitat conditions, but the specific role of each is unknown. Experiments will be needed to direct the program toward actions that provide the most improvement in fish populations.

Because of the difficulties in answering these questions, the program will proceed on available information and theories. Adaptive management will test these theories through controlled experiments and pilot studies, rather than the wholesale implementation of actions.

With limited resources (e.g. dollars, land, water, time) a careful approach is necessary for success. Priorities and degree of experimentation in the program will depend on the extent to which each resource is limited. With many possible directions toward restoration, those routes with the most promise and equity must be found. The challenge will be to find an effective solution that is equitable, balanced, and least costly. Coming up with such a solution will require knowledge of factors and interactions that presently does not exist.

Adaptive management can help increase our knowledge and overcome uncertainty as the results of early actions are monitored. However, adaptive management is not a prescription to conduct a series of very modest restoration projects and monitor results until all uncertainly is dispelled. A system as large, complex, and troubled as the Bay-Delta demands that we pursue large-scale implementation of actions most likely to achieve ecosystem management objectives. A less ambitious approach would not yield observable results and would result in an unacceptably long recovery period for the ecosystem.

Not all actions will be experiments. Some early steps will be proven solutions to serious problems that have already been identified. Actions such as the screening of unscreened diversions may require some degree of experimentation to work out details of cost, engineering feasibility, and ecological considerations, but necessary actions are relatively clear.

Adaptive management will allow more focus on ecosystem functions: those factors that are necessary to populations of important fish and wildlife. This is essential for successful ecosystem restoration.

Adaptive management will also provide more focus on geographic differences and watershed units. The experimental approach focuses on specific watersheds or watershed units. Focusing intensively on a watershed provides a comprehensive view of the status and behavior of program actions without the need to extend efforts to the entire system. Upon testing, the program can be expanded within a watershed and to other watersheds, recognizing the inherent differences among the watersheds.

In the overall restoration program, adaptive management should be implemented on a project-by-project basis, as each project may have its own specific needs for monitoring and research, as well as risk and uncertainty with regard to technical feasibility and cost.

An adaptive management approach will mean the program will proceed on a broad front with many pilot and experimental projects at the watershed level that test the effectiveness and technical feasibility of actions. As the program matures, larger scale projects will be pursued as information is gained from early pilot studies and experiments. This approach will not preclude early implementation of large scale projects that address identified needs and have a sound technical basis. There is considerable information available to implement an adaptive approach immediately for some program elements. Review and analysis of such information may preclude the need for some "experiments."

To be successful, adaptive management in the CALFED program will need institutional structures to carry out the program, get funding, and make future decisions and adjustments. The CALFED program will develop the supporting institutions from existing agencies and stakeholder groups. If these existing structures are insufficient, new institutions may be created.

REQUIREMENTS OF THE ADAPTIVE ECOSYSTEM MANAGEMENT PROGRAM

Objectives and Targetsf

A vision for the future expressed as objectives is needed to guide the adaptive management program. Targets are the basis for experiments to test mechanisms for achieving the objectives.

Hypotheses

Where uncertainty prevails and first steps toward objectives require pilot studies and experiments, scientific and testable hypotheses should be developed.

Priorities

Priorities will be based on critical needs of important resources. Where research is needed before actions can be taken to preserve important resources, this research will be given high priority.

Monitoring

Monitoring linked to hypotheses and research is an essential part of adaptive management. It provides information on the relative success toward reaching objectives and provides key information on the process (e.g. costs, risks, schedule).

Research

Like monitoring, research is an important element of adaptive management. Research may be needed to develop effective monitoring techniques, establish causes, or test techniques that may have uncertain outcomes.

Models

Because of the lack of available information and understanding of complex ecosystems, ecological modeling tools can be valuable in an adaptive ecosystem management program. Models are used to predict system responses through manipulation of controlling or limiting factors based on available information or theory. Models can help guide the program toward areas of uncertainty and document what is learned. Uncertainties can be built into a model and then tested through direct manipulation of the ecosystem. Models also need verification through experiments. Models also test the accuracy of information being used in the program. Models can also simulate various possible outcomes to provide a measure of confidence.

Everett et al (1994) suggests using simple risk analyses models to assist decision makers in determining the relative success of experiments in meeting goals and objectives. As with any model, assumptions and conclusions should be verified to ensure it is a valuable and accurate tool.

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APPENDIX C

Glossary of Terms

AF Abbreviation for acre feet; the volume of water that would cover one acre to a depth of one foot, or 325,851 gallons of water. On average, could supply 1-2 households with water for a year.

Alternative A collection of actions or action categories assembled to provide a comprehensive solution to problems in the Bay-Delta system.

Action A structure, operating criteria, program, regulation, policy, or restoration activity that is intended to address a problem or resolve a conflict in the Bay-Delta system.

Action Category A set of similar actions. For example, all new or expanded off-stream storage might be placed into a single action category.

Anadromous Fish Fish that spend a part of their life cycle in the sea and return to freshwater streams to spawn.

Best Management Practices (BMP) An urban water conservation measure that the California Urban Water Conservation Council agrees to implement among member agencies. The term is also used in reference to water quality standards.

Carriage Water Additional flows released during export periods to ensure maintenance of water quality standards and assist with maintaining natural outflow patterns in Delta channels. For instance, a portion of transfer water released from upstream of the Delta intended for export from south Delta would be used for Delta outflow.

Central Valley Project A federal water conveyance system that pumps water from the Delta for agricultural, urban domestic, and industrial purposes.

***Central Valley Project Improvement Act* (CVPIA)** This federal legislation, signed into law on October 30, 1992, mandates major changes in the management of the federal Central Valley Project. The CVPIA puts fish and wildlife on an equal footing with agricultural, municipal, industrial, and hydropower users.

CFS An abbreviation for cubic feet per second.

Channel Islands Natural, unleveed land masses within Delta channels. Typically good sources of habitat.

Common Pool This concept suggests the Delta represents a common source of fresh water supply for all users of water which in a natural state would be tributary to the Delta. Users of the common pool will share in the benefits and responsibilities for maintenance of the levee system, protection of the fresh water supply in the Delta, and protection of Delta ecosystem quality.

Component A group of related action categories; the largest building blocks of an alternative.

Conjunctive Use The operation of a groundwater basin in combination with a surface water storage and conveyance system. Water is stored in the ground water basin for later use in place of or to supplement surface supplies. Water is stored by intentionally recharging the basin during years of above-average water supply.

Conveyance A pipeline, canal, natural channel or other similar facility that transports water from one location to another.

Delta Islands Islands in the Sacramento-San Joaquin Delta protected by levees. Delta Islands provide space for numerous functions including agriculture, communities, and important infrastructure such as power plants, transmission lines, pipelines, and roadways.

Diversions The action of taking water out of a river system or changing the flow of water in a system for use in another location.

Drought Conditions A time when rainfall and runoff are much less than average. One method to categorize annual rainfall is as follows, with the last two categories being drought conditions: wet, above normal, below normal, dry critical.

Dual Conveyance System A means of improving conveyance across the Bay-Delta by improving through Delta conveyance and isolating a portion of conveyance from Delta channels.

Ecosystem A recognizable, relatively homogeneous unit that includes organisms, their environment, and all the interactions among them.

Entrainment The process of drawing fish into diversion pumps along with water, resulting in the loss of such fish.

ESA (Endangered Species Act) Federal and State legislation that provides protection for species that are in danger of extinction.

Export Water diversion from the Delta used for purposes outside the Delta.

Fish Migration Barriers Physical structures or behavioral barriers that keep fish within their migration route and prevent them from entering waters that are not desirable for them or their migration pattern.

Fish Screens Physical structures placed at water diversion facilities to keep fish from getting pulled into the facility and dying there.

Groundwater Banking Storing water in the ground for use to meet demand during dry years.
HMP (Hazard Mitigation Plan) One of two standards referred to in the alternatives for levee

flood protection. Following the flood disasters of the 1980s, HMP standards were established at 1 foot of freeboard above the 100-year flood event level.

Hydrograph A chart or graph showing the change in flow over time for a particular stream or river.

In-lieu Groundwater Banking Replaces groundwater used by irrigators with surface water to build up and save underground water supply for use during drought conditions.

Inverted Siphon A pipeline that allows water to pass beneath an obstacle in the flow path. For example, an inverted siphon could be used to allow water in a canal to pass under a Delta channel.

Isolated Conveyance Facility A canal or pipeline that transports water between two different locations while keeping it separate from Delta water.

Land Fallowing/Retirement Allowing previously irrigated agricultural land to temporarily lie idle or purchasing such land and allowing it to remain out of production for a variety of purposes.

MAF An abbreviation for million acre feet.

Mining Drainage Remediation Controlling or treating polluted drainage from abandoned mines.

Meander Belt Protecting and preserving land in the vicinity of a river channel in order to allow the river to meander. Meander belts are a way to allow the development of natural habitat around a river.

Non-native Species Also called introduced species or exotic species; refers to plants and animals that originate elsewhere and are brought into a new area, where they may dominate the local species or in some way negatively impact the environment for native species.

Real-Time Monitoring Continuous observation in multiple locations of biological conditions on site in order to adjust water management operations to protect fish species and allow optimal operation of the water supply system.

Riparian The strip of land adjacent to a natural water course such as a river or stream. Often supports vegetation that provides the best fish habitat values when growing large enough to overhang the bank.

Riverine Habitat within or alongside a river or channel.

Setback Levee A constructed embankment to prevent flooding that is positioned some distance from the edge of the river or channel. Setback levees allow wildlife habitat to develop between the levee and the river or stream.

Shallow Water Water with little enough depth to allow for sunlight penetration, plant growth, and the development of small organisms that function as fish food. Serves as spawning areas for Delta smelt.

Smolt A young salmon that has assumed the silvery color of the adult and is ready to migrate to the sea.

Solution Principle Fundamental principles that guide the development and evaluation of Program alternatives. They provide an overall measure of acceptability of the alternatives.

State Water Project A California state water conveyance system that pumps water from the Delta for agricultural, urban domestic, and industrial purposes.

TAF An abbreviation for thousand acre feet, as in 125 TAF or 125,000 AF.

Take Limit The numbers of fish allowed to be lost or entrained at a water management facility before it must limit or cease operations. The numbers are set for different species by regulations.

Terrestrial Types of species of animal and plant wildlife that live on or grow from the land.

Through Delta Conveyance System A means of improving conveyance across the Bay-Delta by a variety of modifications to Delta channels.

Water Conservation Practices Those practices that encourage consumers to reduce the use of water. The extent to which these practices actually create a savings in water depends on the total or basin-wide use of water.

Water Reclamation Practices that capture, treat and reuse water. The waste water is treated to meet health and safety standards depending on its intended use.

Water Transfers Voluntary water transactions conducted under state law and in keeping with federal regulations. The agency most involved is the State Water Resources Control Board (SWRCB).

Watershed An area that drains ultimately to a particular channel or river, usually bounded peripherally by a natural divide of some kind such as a hill, ridge, or mountain.

CALFED
BAY-DELTA
PROGRAM

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CALFED Bay-Delta Program

Public Involvement Calendar

1996

Month	Date	Event	Location	Contact
November	6	BDAC Assurances Work Group	1416 Ninth Street, Room 1412 Sacramento 9 a.m. - Noon	Mary Scoonover
	7	BDAC Water Use Efficiency Work Group	1416 Ninth Street, Room 1131 Sacramento 1:30 p.m. - 4:30 p.m.	Rick Soehren
	19	Introduction to Restoration Goals and Targets Workshop	Beverly Garland Hotel 1780 Tribute Road Sacramento 9 a.m. - 5 p.m.	Dick Daniel
	20	BDAC Finance Work Group	Burbank Airport Hilton Burbank 3 p.m. - 5 p.m.	Zach McReynolds
	21	BDAC Meeting	Burbank Airport Hilton Burbank 10 a.m. - 5 p.m.	Sharon Gross
	26	BDAC Ecosystem Restoration Work Group	1416 Ninth Street, Room 1412 Sacramento 9 a.m. - Noon	Dick Daniel
December	2	BDAC Water Use Efficiency Work Group	1416 Ninth Street, Room 1131 Sacramento 1:30 p.m. - 4:30 p.m.	Rick Soehren
	13	BDAC Assurances Work Group	1416 Ninth Street, Room 1131 Sacramento 9 a.m. - Noon	Mary Scoonover
	17	Levee Workshop (still tentative)	Location to be announced 9 a.m. - 1 p.m.	Mary Kelley
	17	Water Use Efficiency Workshop (still tentative)	Location to be announced 1 p.m. - 5 p.m.	Rick Soehren
	18	BDAC Ecosystem Restoration Work Group	1416 Ninth Street, Room 1131 Sacramento 9 a.m. - Noon	Dick Daniel

Current as of October 30, 1996

Please Note: Changes may occur to this schedule. Confirm time/date/place by calling the CALFED Bay-Delta Program Hotline at (916) 654-9924.

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